Macintosh

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Multimedia Solutions: Designing an Interactive Media Station

Thanks to Paul T. Pashibin, Apple Multimedia Specialist, for contributing this article.

From the beginning, the Apple® Macintosh® computer was designed to take advantage of text and graphics, giving everyone from businesspeople and educators to artists and engineers a new way to integrate information and ideas in a single system. The Macintosh offers you the flexibility to choose not only the hardware platform on which to build, but also the software that most effectively communicates the ideas and information you have in mind—whether you're designing a color presentation that incorporates text, spreadsheet graphics, and line art illustrations, or creating a full-scale animation sequence that includes real-time video and stereo sound. All these things are possible with Macintosh today. And they're easier to accomplish than you might imagine.

What Is Interactive Media?

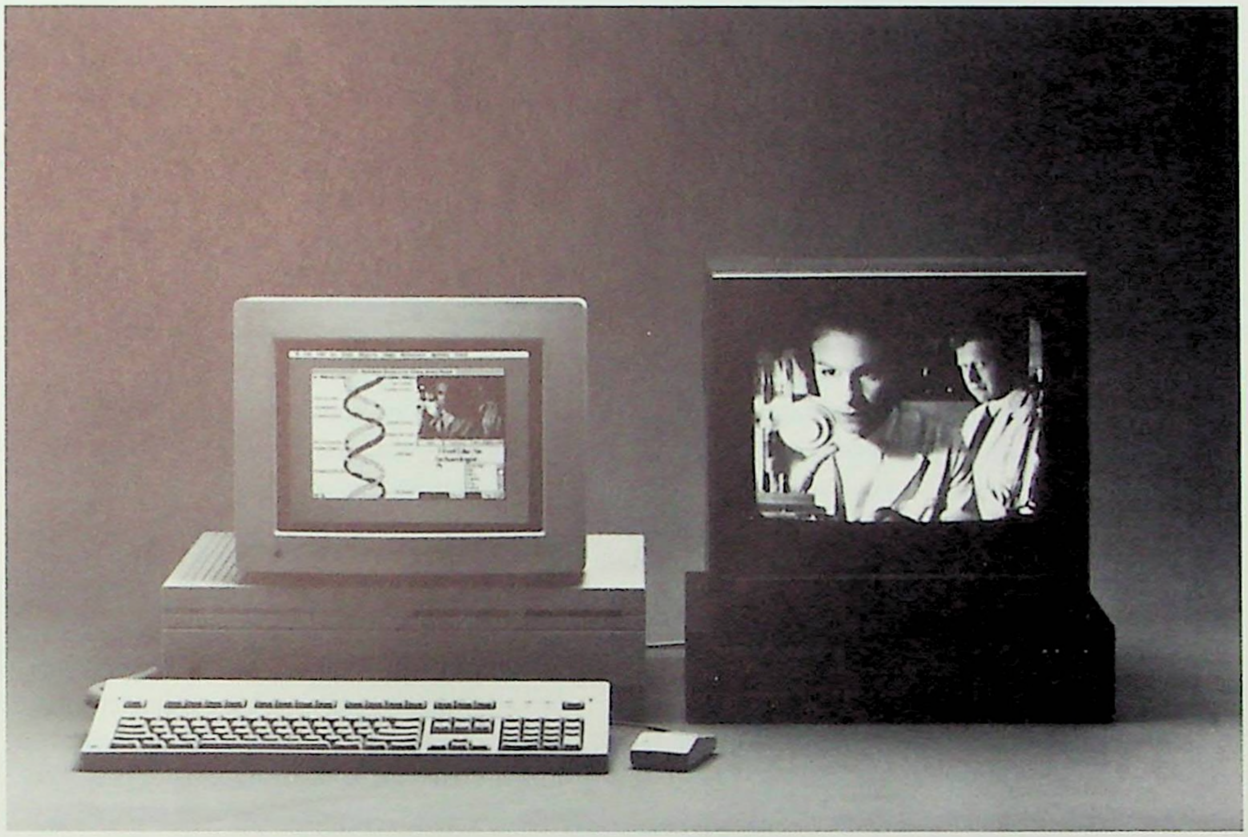
A new approach to publishing and presentations has emerged that allows viewers to relate interactively to the information being presented, enabling them to get the information they want and need much more quickly.

This new technology, termed *interactive media,* gives people the flexibility to view important information in a nonlinear fashion—one that is unique to them and attracts and holds their attention, helping them to retain more of the information they obtain by hearing, seeing, and doing.

What Is Multimedia?

Multimedia is the integration of text, graphics, sound and voice, color photographs, and moving pictures—live video—brought together into one platform, and displayed in an interactive format so that users can access the information as they like. It allows you to communicate your information to a single person through a newsletter, to a group of people through an animation or tape, or to a large group of people through a slide show or presentation incorporating all means of delivery, including live video. Think of the person at the computer as the navigator on a boat. That person can take any course to get to the location of specific information, bypassing all other information and being able to access the information as needed. A totally interactive format allows users to start at any given point and to stop when they've finished browsing information. (See the photograph on the opposite page.)

Interactive media and multimedia might be considered as the same thing, and people tend to use the terms in conjunction. I like to think of multimedia as the forms of media, thus "many media," and interactive media as the "tool" for delivering the media. If I could use one word to describe the capabilities listed in the preceding paragraphs, I would use the term "hypermedia," an all-encompassing word for the formulation of the media and the tools to deliver them. For more information on the origins of hypermedia, watch for the PBS show "HyperLand," airing on your local public broadcast or education channels. Further information can be found in Michael Frase's book *Macintosh Hypermedia: A Resource Guide,* published by Scott, Foresman.



This is an example of a multimedia design developed by Apple's Multimedia Lab, Lucasfilm, Inc., and the Smithsonian Institute. The program involves users in the discovery of DNA and lets them explore the methods and ethics of science (based on a documentary by the British Broadcasting Corporation).

Whatever you call it, delivering information to the masses is easily accomplished with the appropriate Macintosh configuration. You may be reading this article because you want to assemble your own hardware and software multimedia station for courseware development. You may be interested in animations, presentations, or image processing and visualization. For any of these purposes, you can start with the Macintosh computer.

Building a Station for Presentations

The basic concept of an interactive presentations workstation is that it gives you the tools you need to present multimedia to large or small groups. You can control and access video images on a video laserdisc or VCR, and then display the live video on the Macintosh monitor, an external television monitor, or a large-screen projection device.

Such an interactive station also allows you to reference the information housed in the hard disk of the computer, as well as the information and images on existing laserdiscs. You can send the Macintosh computer screen image into the projection device you use for video, or you can use an LCD (liquid crystal display) overhead projection pad. You might use this method of presenting multimedia because it's more effective than typical overhead or chart presentations. Because of the Macintosh computer's seamless integration of text, graphics, sound, animation, and video, a multimedia presentation captures the audience's attention and sustains interest.

Do not limit yourself to using this station for presentations alone. With the right choices in hardware and software, this station can double as an interactive sound station, an imaging station, or any one of the stations outlined in this article. And because it is a Macintosh, you have access to more than 3,000 applications for business, education, and entertainment.

A Macintosh Plus or later model, with a hard disk, can serve as the basis for the presentations workstation. With software such as Apple HyperCard® or MacroMind Director 2.0, you can use scripts to control and display your entire presentation. The Voyager VideoStack Version 2.0, available through APDA® (Apple Programmers and Developers Association), can control the laserdisc player, so that you can access any one of the 54,000 frames of live video or still images on the disc. Through APDA, Apple also offers the following toolkits, which contain external commands (XCMDs): the HyperCard Videodisc Toolkit, HyperCard CD Audio Toolkit, HyperCard Serial Communication Toolkit, and HyperCard AppleTalk® Toolkit.

The laserdisc player must be an "industrial" player, which means that it has a serial interface, connecting to the Macintosh with an RS-232C serial cable. The laserdisc image can be viewed on the television or routed to a large-screen projection device. With a Macintosh II computer and a video card that supports live video in a window on the Macintosh screen, you can display both the live video and the Macintosh graphics and text on a single screen. You may also want to add self-powered speakers, which are recommended for higher sound clarity and volume. You can route both the Macintosh sound and the laserdisc sound into the speakers by using a small audio mixer.

Building a Station for Interactive Sound

An interactive sound workstation integrates sound into a multimedia project. It lets you create HyperCard stacks or MacroMind Director animations that have high-quality digitized sound effects. You can create and edit audio using various software packages, produce the actual sounds using peripheral devices, and play them back using sequencer software. The results can range from a HyperCard presentation with synchronized sound and narration to an on-stage performance at your next office get-together.

Sound heightens audience interest in a presentation by providing a more realistic experience of the subject matter. It also helps to highlight and reinforce key concepts. Sound on the Macintosh falls into one of two categories: MIDI and digital.

An Apple MIDI interface allows the industry-standard connections from the serial port on any Macintosh computer to a MIDI-compatible controller. MIDI software provides powerful editing features to assist you in arranging sounds. MIDI sequencing does not impose heavy hardware requirements on its users because the sound is reproduced by synthesizers and samplers with dedicated RAM, rather than being reproduced by the Macintosh.

"Digital audio" refers to the numerical representation of sound waves. CDs are a common digital format. The quality of digital audio depends on the rate at which it is sampled; CD-quality audio is sampled at 44.1 KHz. Digital audio requires a hard disk; you will find that even small samples of sound can require large amounts of hard disk space. For example, one minute of CD-quality digital sound requires 10 megabytes of storage space.

If you want to create sounds, an Apple Macintosh Plus or later model with a hard disk can serve as the basis for a MIDI sequencing station, providing you with enough power to digitize some sound with medium quality. You will want to have at least one MIDI-compatible, multitimbral (capable of producing more than one timbre or instrument sound simultaneously) synthesizer or sampler, and MIDI sequencing software. You will also need sequencing software to create and edit your sounds. A MIDI interface and MIDI cables connect the synthesizer or sampler to the Macintosh.

For digitized sound, Farallon's MacRecorder is a popular low-cost sound digitizer that allows you to digitize sound with acceptable quality at lower sampling rates. MacRecorder works with the Macintosh Plus and later Macintosh models.

Digitizing CD-quality audio at a 44.1-KHz sampling rate requires a more powerful computer with 4 megabytes of RAM or more. A Macintosh IIx, Macintosh IIci, or Macintosh IIfx computer is needed for working with expansion cards such as DigiDesign's AudioMedia or Sound Tools. These systems allow you to achieve true CD-quality digital audio through the circuitry on a NuBus™ card installed in the computer. A high-capacity, quick-access hard disk is also recommended.

No matter what you want to do with sound, you need a way to play what you have created. Your home stereo may be perfect for the purpose. If you require portability, a set of self-powered speakers can be connected to the audio output port on either the Macintosh or a synthesizer. You may even want to purchase a mixing console or power amplifier—a common solution used with medium-size to large audio setups. Another peripheral that you may want to consider is the AppleCD SC® CD-ROM drive,

Macintosh II with CD-ROM Drive

which acts as a large-capacity storage device for computer data and allows for the playback of standard audio CDs through the headphone jack output port, located on the front of the unit, and auxiliary audio output ports, located on the back. With a digitizer, sound can be captured via these ports into the Macintosh for later editing or playback.

Building an Interactive Desktop Video Station

A desktop video station enables you to combine real-time video images from a laserdisc or VCR, and still images from a digital camera or scanner, with computer-generated images and animations—finally allowing for display on an NTSC monitor or recording the images on videotape. (NTSC stands for National Television Standards Committee; see "NTSC/RS-170," on page 34.) When video is incorporated with computer graphics, it can help illustrate specific points and highlight and reinforce key concepts. With the proper hardware selections, you can create your own animations and record them on videotape, or create your own videotapes for distribution at an internal training session or product marketing campaign.

An Apple Macintosh IIx, Macintosh IIci, or Macintosh IIfx is required for this station, as the video overlay card is needed to "genlock" the two signals (the RGB and NTSC sources) for display on an NTSC video monitor. A hard disk is recommended; the video input source could be a laserdisc, a VCR, a still digital camera, or a video camera or camcorder.

An interactive desktop video station requires a video overlay card with inputs for NTSC, and outputs for NTSC and possibly RGB video. The Macintosh video signal (RGB) is placed over the NTSC signal, and both signals are sent to a video monitor and/or videocassette recorder. The higher-end cards sometimes allow for capture (the ability to bring live video images into the computer). Some cards might even include the additional feature of live video in an interactive or programmable window. For more information about video cards and the selection process, please read "Multimedia Solutions: Video Card Selection" on page 8.

Building an Interactive Media Development Station

The interactive media development station incorporates all the stations described in this article into one "superstation." A Macintosh IIfx is most appropriate for this station, because its power and expansion capabilities are unmatched in the PC community. For those who create animations, videotapes, sound tracks, voice-overs, interactive kiosks, training tapes and courseware, slides, presentations, and desktop publishing, this station does it all. The IIfx has a maximum capacity of 8MB of RAM, and it should have an internal 160MB hard disk and one or two external hard disks. A removable cartridge drive is a convenient means for moving final presentations to another workstation for display. The AppleCD SC drive might be attached for sound, and a color scanner for importing still images. Take care when you select a video card; pick one that has a mixture of features, so that you don't have to develop on one card, and then switch to another to get your project onto videotape.

My Station

My station is based on the interactive media development station. However, it can also be used in any one of the other station configurations. I travel around my five-state territory, talking to people about the Macintosh as the ideal multimedia solution. I need to be able to demonstrate capabilities that range from media development and animations sent from the Macintosh to videotape, to interactive presentation workstations and image visualization and processing. Between demonstrations, I also need a workstation that lets me complete my work, get my mail, do expense reports and budget forecasting, and write articles. My multimedia station consists of the following hardware:

- A Macintosh IIx with 8MB of RAM and a 160MB internal hard disk drive
- An AppleColor™ High-Resolution RGB Monitor (often called the Apple 13-inch monitor)
- An Apple Extended Keyboard
- An AppleCD SC
- A PLI 44MB removable cartridge drive
- A Pioneer 4200 laserdisc player
- Yamaha KS-10 external powered speakers
- Realistic four-track audio mixer console
- Farallon MacRecorder
- Sony SL-50 VCR
- JVC GX-N7U Color Video Camera
- Sony CPD-1302 13-inch Color Multisync Monitor

I did not list a video card for the monitor because I have more than 10 cards that I can use. Each performs a certain task or series of tasks, from text and graphics display only to video-in-a-window and video overlay. (For more information on selecting a card, see "Multimedia Solutions: Video Card Selection," on page 8.)

Multimedia on the Macintosh computer is exciting. It gives you and your audience a new way to look at information, by amplifying ideas and by allowing users to access information, stored as many media and available on the desktop of the Macintosh computer. Your selection process for designing a multimedia station starts with the definition of an ongoing project, continues with the development of that project, and ends when your audience uses your information in a multimedia environment. With the information provided here, you can design the station that best fits your needs.

Multimedia Solutions: Video Card Selection

Thanks to Paul Pashibin, Apple Multimedia Specialist, for contributing this article.

More than 50 video cards are available for the Macintosh II line of modular computers. Considering the large number of solutions, along with the hundreds of configuration options, it's no wonder that many people get confused about selecting a display card for multimedia uses.

Simple Solutions

Apple has four display cards that work with any of four Apple monitors. That creates 16 configurations of Macintosh, monitor, and display card—not including third-party monitors that work with these cards. Apple makes the configuration and installation process a little easier by having one standard cable configuration, a 15-pin Apple video cable. The Apple video cards are the following:

- The Apple Monochrome (1-bit) Display Card displays a black-and-white picture on any Apple monitor, except the Apple Macintosh Portrait Display and the Apple Two-Page Monochrome Monitor. Designed for file servers and workstations where low cost and minimal graphics are required (such as word processing stations), this is an entry-level display card that cannot be upgraded.

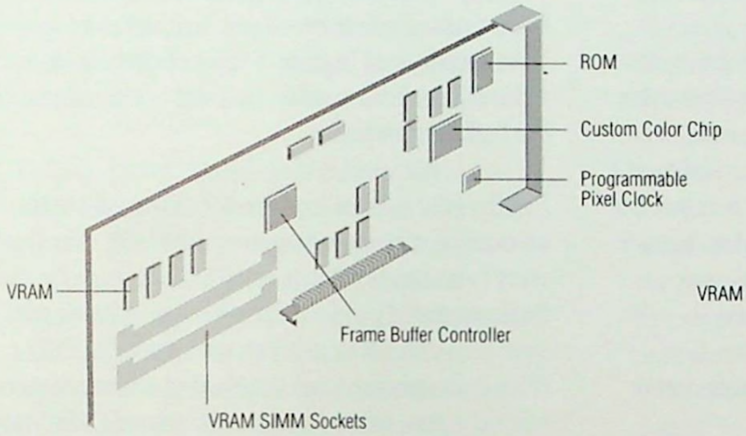
- The Macintosh Display Card 4•8 drives all Apple monitors at the lowest-configurable display specifications. It provides support for up to 256 shades of gray on the Apple High-Resolution Monochrome Monitor, up to 256 colors or shades of gray on the AppleColor High-Resolution RGB Monitor, and up to 16 shades of gray on the portrait display and the two-page monitor. The Macintosh Display Card 4•8 can be upgraded to the Display Card 8•24 with the Macintosh Display Card VRAM Kit.

- The Macintosh Display Cards 8•24 and 8•24GC support all Apple displays to the maximum of their capabilities, including full 256-level "true gray scale" on all Apple displays. The cards also support full 24-bit "true color" capability on the AppleColor High-Resolution RGB Monitor, allowing users to display any of 16.7 million colors simultaneously. The combination of true gray scale and true color capabilities lets you display and work with photographic-quality images as well as with lifelike simulations, animations, and visual effects.

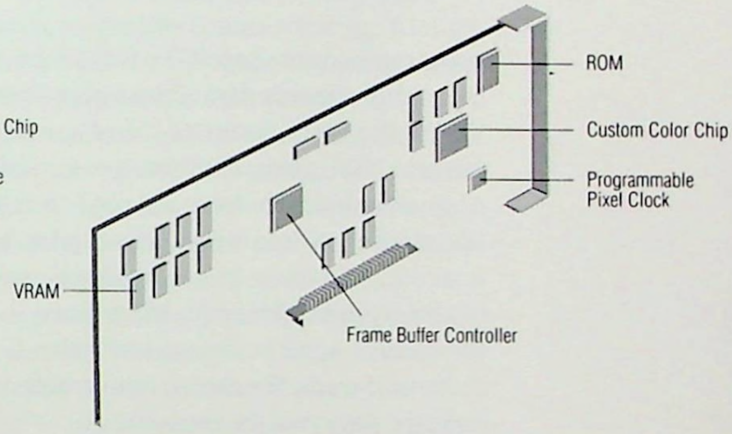
- The Macintosh Display Card 8•24GC is configured in the same way as the 8•24 card, except that it includes an AM29000 RISC-based graphics coprocessor running at 30 megahertz. (GC stands for "graphics coprocessor.") The processor, when turned on through a Control Panel device, intercepts all QuickDraw™ commands and accelerates them, using RISC (Reduced Instruction Set for Computers) technology to accelerate screen refresh and the display of QuickDraw graphics to the screen.

  The Macintosh Display Card 8•24GC can be upgraded with the Macintosh Display Card DRAM Kit, which improves the performance of applications that use large off-screen bitmaps and other imaging methods.

Macintosh Display Card 4•8 and Macintosh Display Card 8•24

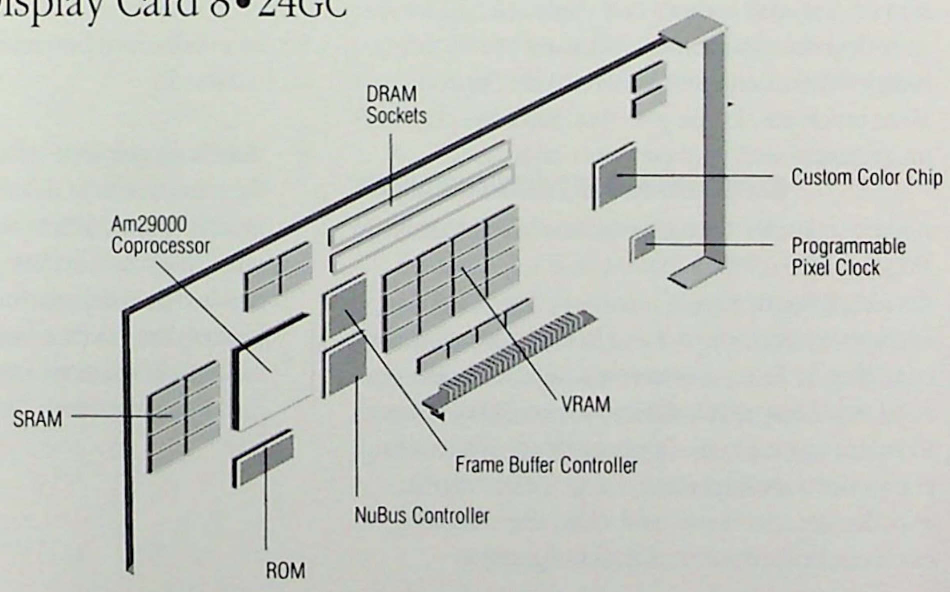


Macintosh Display Card 4•8



Macintosh Display Card 8•24

Macintosh Display Card 8•24GC



In addition to Apple monitors, the 4•8, 8•24, and 8•24GC cards can drive certain third-party monitors via specific cable configurations.

Apple cards do not support live NTSC video, video capture, or video overlay. (By using the Truevision VIDI/O Box or the RasterOps VideoExpander, you can have NTSC output to monitors or to videotape.) Apple video cards are "plug and play"; there are no DIP switches, no interrupt switches, and no hassles. In most cases, you are free to upgrade as your system expands. Third-party video cards complement Apple's offerings, and in the multimedia arena, these video card manufacturers make the Macintosh the ideal solution.

Video Cards: The Selection Process

When selecting a card, you must first define your needs. Feature sets vary, and just as one card may provide many features, concentrating on doing one feature very well, another card might specialize by providing one feature only. What are your needs today? Where do you want to be in the future? What purchases do you plan that might be incompatible with your current configuration?

Another consideration is "real estate": How many slots does the solution require, or is it an external device? If you're using a Macintosh IIcx or IIci, for example—both three-slot machines—preserving the capability for future expansion is important. Do you need video output (the ability to send digital images to video) and capture? Or just capture? What other components are important? Items such as cables, encoder/decoder boxes, and videotape controller cards can boost the cost of the configuration.

What level of quality do you want? Will you use your system for in-house educational videos? If so, you may not require the highest standards—the higher-priced solutions. If you happen to be in a video production firm, or if you need the final signal to be of broadcast quality, you may want a signal of the highest standards.

Finally, who is your "customer"? Who will see the animation, capture, or videotape project? You don't want to recommend that an NTSC videotape be the final generated product if that tape is to be viewed overseas. Most European countries use the PAL (Phase Alternating Line) standard of 25-frames-per-second video, while American standards (NTSC) are 30 frames per second. Admittedly this is an unlikely scenario, but it shows that by asking yourself the proper questions, you can assemble the most satisfactory solution.

What to Look For

Six features define Macintosh display card solutions for multimedia:

- Macintosh graphics/text display. These cards, the most common and generic products available, provide text and graphics capabilities only. They usually drive only a specific monitor. Because the cards don't support live video or capture, they are not frequently used for multimedia solutions. An example of such a card is the Macintosh Display Card 4•8.

- Color depth (24/32-bit graphics display). These cards provide direct color (16.7 million colors) display of text and graphics on screen. Usually they include other features such as capture or pan/zoom and virtual desktop. An example is the RasterOps 224 card.

- Video capture. These cards can capture a live video image (in most cases, in color). They may provide live video on the Macintosh screen or they may require a second NTSC monitor. These cards capture a video shot and allow you to save it in PICT or TIFF format for future editing and incorporation into presentations or animations. An example is the RasterOps FrameGrabber 324.

- Video overlay. These devices genlock a Macintosh video signal (that is, they synchronize video processing circuitry with another camera or video card), overlay Macintosh graphics and titles over live video, and output to standard video equipment, such as video projectors and videotape recorders. An example is the Truevision NuVista.

- NTSC output. Generally, cards that provide video overlay also provide NTSC output. However, you can have NTSC output without video overlay. Examples are EasyVideo 8 from MASS Microsystems, and the Macintosh Display Card 4•8, 8•24, 8•24GC with an encoder box (VIDI/O from Truevision or VideoExpander from RasterOps).

- Video-in-a-window. These cards provide display of live video in a Macintosh window, and they allow you to capture the current image. The most sought-after feature is the capability to display a direct color (24-bit) NTSC image on the Apple High-Resolution RGB Monitor—quite a task if you understand that you cannot display ordinary television (NTSC) graphics on an RGB monitor without a conversion of some type. In some cases, the conversion process slows down the real-time display on the screen from 30 frames per second to 15 frames per second, and may also dither the images. (Dithered color relies on grouping a number of pixels in a pattern to approximate a color.) The best cards simulate 30 frames per second in 24-bit mode. An example is the RasterOps 364 card.

External devices can be used to capture a frame and save it to disk, or to do character generation for video overlay and genlock. The benefit of an external device is that most are driven by the SCSI port on any Macintosh, and can be used on the compact line of Macintosh computers such as the Macintosh SE and Macintosh Plus. An example is the Pixelogic ProViz.

Macintosh Video Products

The following information is presented to outline specific features and benefits of popular cards on the market today. I own many of them, and have used them in my Macintosh IIX multimedia station. For more information about the products, contact the companies listed at the end of this article.

- **Aapps DigiVideo Color**
  The Aapps DigiVideo Color card displays video-in-a-window from any composite video source, VCR, video camera, laserdisc player, or cable television. It includes field capture in 8-bit color at 1/60 second, and frame capture in 24-bit color. DigiVideo Color offers desk accessory control for Pioneer LD V-4200 laserdisc players, with modular extensions for other video sources. HyperCard 2.0 support includes color and gray-scale video capture into stacks.

- **Computer Friends ColorSnap-32+**
  ColorSnap-32+ combines real-time video image capture with image compression and stereo audio digitizing. Moving images can be captured from live cameras, laserdiscs, VCRs, and television monitors. The Viewfinder feature allows you to preview the video input on a small window on the Macintosh screen, and the Gallery feature lets you create image databases with editable file names, comments, and search words linked to each image. With the audio digitizer input option, you can attach digitized stereo sound to captured images, and the added compression utility saves disk space when you're dealing with a large number of images. Accompanying software allows saving images in PICT format (from 1- to 32-bit), as well as 8- and 24-bit TIFF files.

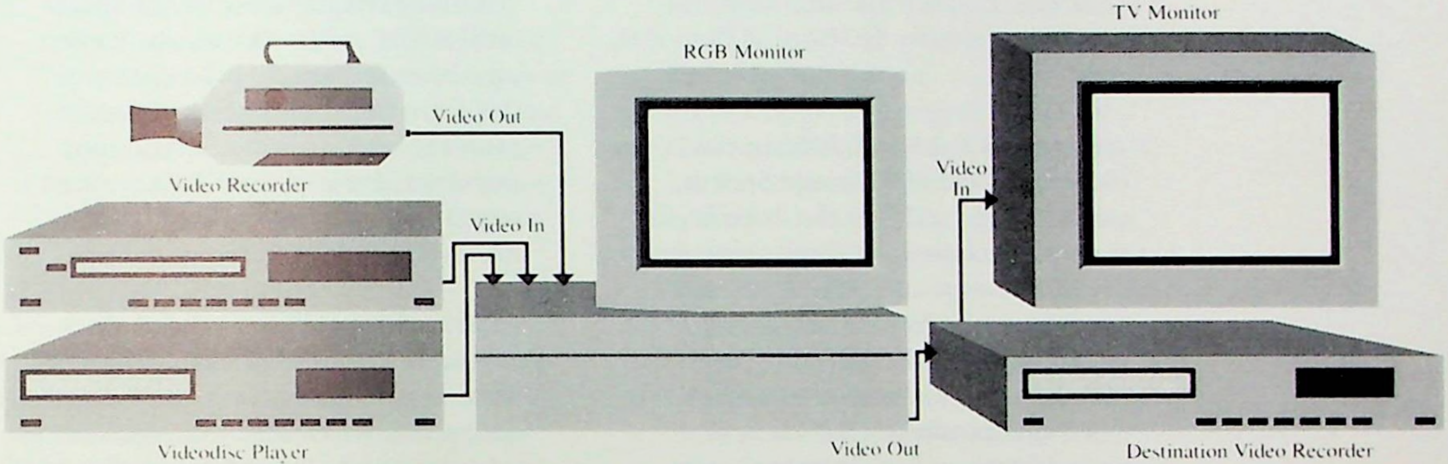
- **Digital Vision ComputerEyes/Pro**
  ComputerEyes/Pro is a full-color (24-bit) video digitizer that captures images from any standard video source for professional-quality imaging. The video signal is scanned and images are captured as PICT and TIFF files. Images can then be modified with image manipulation options, or imported to other graphics programs.

  This single-card solution has connections for either standard composite or S-Video signals. Images can be captured and displayed in 8- or 24-bit color or in black and white.

  This is an inexpensive solution for single-frame capture at 24-bit resolution. It requires the video signal to be still for an average of six seconds, requiring something like a high-quality tape deck or a CAV laserdisc with Pause turned on.

- **MASS Microsystems ColorSpace IIi**
  ColorSpace IIi is an NTSC/RGB-compatible genlocking video graphics card for the Macintosh II. It allows you to overlay 256-color graphics over live or videotaped background pictures that are input from a VCR, videodisc, camcorder, or video camera. It is a single-card solution that offers a number of graphics features, such as translucent graphics and a dimmed video background. The product also captures and provides simultaneous output in RGB and NTSC.

  Although ColorSpace IIi works with the Apple 13-inch color monitor, you don't get real-time live video on the screen; you'll need a third-party NTSC monitor for that feature. You could have the Macintosh graphics on the Apple monitor, and the live video and Macintosh graphics overlaid on the external monitor. The NTSC signal could then be sent to a videotape recorder. To use live video-in-a-window, the ColorSpace FX (see the next page) can be added to a Macintosh system with the ColorSpace IIi.



An Advanced Video Production Setup

Advanced video production. The system: Macintosh II computer; ColorSpace IIi; ColorSpace FX; source video camera; two other video sources (videotape players, cameras, or laserdisc players); destination videotape recorder; and NTSC or PAL monitor.

- **MASS Microsystems ColorSpace FX**
  ColorSpace FX is a full-color, special-effect video processor card that provides real-time video and image manipulation capabilities. To work with the Apple 13-inch color monitor, the card must be used along with the ColorSpace IIi. With its special-effect capabilities, ColorSpace FX can perform picture squeeze, mirror, kaleidoscope, zoom in and out, shrink, anamorphics, and X,Y "subsampling" effects. Its digital video processing includes real-time sharpen, blur, and hue adjustments of full-color, live video images.

  ColorSpace FX automatically captures live NTSC, PAL, or SECAM (Systeme Electronique Couleur Avec Memoire: a French television standard) video input signals in real time, at a rate of 30 frames per second (25 in Europe) and in full color. The card comes equipped with special video processing features, including automatic signal enhancement and sync regeneration, videotape input mode for stabilization of noisy input signals, time-based correction to second video sync, RGB+sync output, and scan rate conversion of the input signal.

  MacroMind Director supports this card very well by sending a Director example file for video in a window. Video Author by HyperPress also supports this card via HyperCard XCMDs.

- **MASS Microsystems ColorSpace Plus/SE**
  ColorSpace Plus/SE is a desktop video production system for the Macintosh Plus and SE computers.

  An external SCSI device, ColorSpace Plus/SE can overlay black-and-white Macintosh text or graphics in color on full-motion, full-color, live or recorded composite NTSC or S-Video. Results can then be sent to any consumer or professional video recording or display device. The product ships with TitleMaker, a HyperCard stack that allows you to create titles over video, providing compatibility with a variety of Macintosh titling and animation applications. It also supports a wide variety of consumer- and industrial-quality video equipment, such as VCRs, videodisc players, and camcorders.

  ColorSpace Plus/SE features an NTSC adaptive vertical filter that provides flicker-free titles and graphics in a television environment. Color-mapped graphic or text overlays permit you to specify two colors for Macintosh screen graphics, bringing color to computers previously limited to monochrome output. Multiple video input connectors allow video input from two video devices (two composite or two S-Video devices).

- **MASS Microsystems QuickImage 24**
  QuickImage 24 is a frame grabber card that instantly captures single or multiple video frames at 1/30 (1/25 PAL) second from any live or recorded NTSC or PAL video source, composite, or S-Video, in 24-bit color and 8-bit gray-scale PICT2 files. A user-selectable Field Capture mode allows users to capture fast-moving objects in motion for sharper images. Field Capture mode grabs images at 1/60 second (1/50 PAL).

  QuickImage 24 features Intelligent Switching, which allows the card to automatically adjust itself for NTSC or PAL video signals. It accepts input from any composite or S-Video source. (S-Video is a standard that separates chrominance and luminance into separate signals, providing higher resolution.) With two input sources, you can switch between two video sources through software.

  A Preview Window allows you to see the incoming video in a window on any monitor. The size and color mode set for the Macintosh display determines whether the video is viewed at 5 to 30 frames per second, but the capture will always happen instantly in the color mode you specify for the output file. The captured window then appears in a window on the desktop; this window can be expanded to full size.

- **Orange Micro Personal Vision**
  Personal Vision is an RGB image capture card that allows you to bring 15-frame-per-second color video to the Apple 13-inch RGB screen. You can scroll and resize the Macintosh window while you are digitizing the image. You can capture images using standard NTSC video sources such as camcorders and video cameras. The product displays images in 8-bit color, but allows capture and saving in full 24-bit color. Personal Vision is supported by third-party HyperCard XCMDs.

- **RadiusTV System**
  The RadiusTV System is a television subsystem for the Macintosh II that consists of a video card, an external audio-video processor, and software that controls and manipulates video images.

With RadiusTV and the Apple 13-inch RGB monitor, the computer displays, stores, and manipulates any video image, including input from broadcast or cable television, videocassette recorders, laserdisc players, video cameras, and digital cameras. It displays video at 30 frames per second, and can monitor as many as three incoming signals at once. RadiusTV does not provide output for digital images.

- **RasterOps FrameGrabber 324**
  The FrameGrabber 324 is a video input digitizing card that captures images in true color from videotape, RGB, NTSC, or S-Video, or from a live video source in 1/30 of a second. It supports NTSC, PAL, and S-Video standards, and is RGB camera-ready. It saves images in 8- or 32-bit formats. This single-card 24-bit solution can be used with the Apple 13-inch color monitor.

- **RasterOps ColorBoard 364**
  This 24-bit card features a 30-frame-per-second frame grabber, which allows you to designate incremental grabs to a fraction of a second. A desk accessory also allows you to grab frames. The ColorBoard 364 provides video-in-a-window, composite and S-Video input, and RGB output to the Apple 13-inch color monitor. It supports HyperCard XCMDs and XObjects for MacroMind Director.

- **RasterOps ColorBoard 224**
  ColorBoard 224 is one of the first cards to support the Apple-Color High-Resolution RGB Monitor with true color, at 24-bit resolution. All 16.7 million colors of text and graphics are available. Other features of this card include pan, zoom, and virtual desktop (a hardware option that provides automatic scrolling to areas of a displayed image that are not visible on the screen).

- **RasterOps SFX Option**
  The SFX Option is an upgrade card for the ColorBoard 224 and 232 that allows mixing of live video input with Macintosh graphics. Features include the following: 256 levels of transparency, linear chroma key, composite and S-Video (S-VHS) input/output, RS-343 interlaced RGB output, and full genlock capabilities.

- **Truevision NuVista+**
  NuVista+ is a video graphics card for the Macintosh II family that couples high-resolution, true-color video capture, display, overlay, and genlock capabilities with a high-speed 32-bit graphics coprocessor.

  A single-slot card, the NuVista+ incorporates Truevision's video encoder/decoder technology (the VIDI/O Box), which digitizes a standard video signal in real time and in full color. The VIDI/O circuitry converts a standard NTSC, PAL, or S-Video signal into an analog RGB signal. It also allows the RGB image to be sent out as NTSC, PAL, or S-Video for recording onto videotape or display on NTSC, PAL, or S-Video monitors or televisions.

  The NuVista+ card includes a digital chroma keyer that provides dynamic merging of live video with computer-generated graphics, and a digital linear keyer that allows you replace a specific segment of video signal with another signal. You can use the digital linear keyer to insert live or still video and to create special effects such as blending, mixing, fading, and dissolving between images.

The card generates a high-quality broadcast analog video output signal. Sophisticated frame capture and display capabilities allow it to produce images of excellent clarity and realism. NuVista also functions as a standard Macintosh graphics card, making it compatible with virtually all Macintosh software.

The NuVista card works with the Apple 13-inch color monitor (with no live video support on that monitor) via a special cable. It also works with multisync monitors of almost any brand and size, providing live video and Macintosh graphics on the same screen. With 1, 2, or 4 megabytes of user-configurable RAM, NuVista also has an 8-megabyte NuVMX RAM option. It provides MacroMind Director support and includes HyperCard XCMDs contained in example stacks that are included with the product.

- **VideoLogic DVA-4000 and MIC System II** The DVA-4000 card, the VideoLogic 8-bit graphics card, and the MIC System II development environment are all included in this package from VideoLogic. It requires two slots on computers in the Macintosh II family and supports the AppleColor High-Resolution RGB Monitor. Although the product was previously available only for IBM PS/2 and compatible machines, the DVA-4000 is not simply ported from DOS. The product, together with MIC System II software, takes full advantage of the Macintosh user environment and conforms fully to Apple's user interface guidelines.

The DVA-4000 offers video-in-a-window from a wide range of video input sources; it accepts composite video, RGB, and S-Video formats in both NTSC and PAL standards. The card supports up to 256 colors and captures 24-bit images in PICT format. Video and graphics can be keyed, mixed, and faded pixel by pixel with up to 256 colors. Color keying allows specific screen colors to be made transparent or translucent in order to show video through a specified area.

MIC (Multimedia Interactive Control) System II software provides a development environment with more than 60 high-level commands that directly control and integrate video, audio, and graphics. MIC commands can be invoked from popular Macintosh development languages such as Pascal, C, and Apple's HyperTalk® scripting language. The MIC CDEV provides interactive control over all audio and video parameters, including brightness, contrast, saturation, hue, sharpness, input type, volume, treble, bass, and stereo/mono. The MIC ToolBox allows effects to be mocked up, altered, and tested. More than 60 MIC control commands can be accessed and executed interactively from within ToolBox, allowing experimentation and preview of results.

DVA-4000 and MIC System II software support Macintosh multimedia development tools such as HyperCard, Authorware Professional, MacroMind Director, and MacroMind MediaMaker. The products are available for Macintosh II systems, as well as IBM PS/2, PC/XT, and PC AT systems (and their compatibles), and support the Macintosh operating system, DOS and Microsoft Windows, and OS/2 Presentation Manager. Multiplatform support ensures a consistent development environment, providing the ability to port applications and maximize development investment.

- **Workstation Technologies WTI Moonraker**
  WTI Moonraker is a single, full-size-card digitizer for the Macintosh II. It allows continuous digitizing of analog input over the NuBus for display in a window on the Macintosh monitor. The product accepts analog video from most common sources, and provides output of converted digital data on any Apple-compatible display system.

  The WTI-Moonraker card can process two live independent video inputs simultaneously for display in two separate windows. It provides digital overlay capability and can produce a variety of special effects. HyperCard XCMDs allow full functional control of the product from HyperCard and SuperCard. Masking functions allow user graphics, fields, and buttons on top of live video. The Image Capture XCMD allows capture of 8-, 16-, or 32-bit video images for saving in the PICT format. The product also includes the WRI Video Manager, an interface for software development.

Product Information

As stated at the beginning of this article, there are many cards and each has its own specific niche, features, and benefits. If it's your job to recommend a product, I hope this article has helped, but you should not stop here. There are many articles on the AppleLink® network and in the trade magazines, such as *Macworld* and *Computer Graphics World.* I suggest the following articles for other useful information:

- *Macworld,* June 1989: "The Macintosh in Film, Video, and Animation"
- *Macworld,* April 1990: "Multimedia: Is it Real?"
- *MacUser,* March 1989: "Multimedia: Interacting with Information"

For more information about the products discussed in this article, please contact the following companies:

Aapps Corporation
756 N. Pastoria Avenue
Sunnyvale, CA 94086
(408) 735-8550
Fax: (408) 735-8670

Computer Friends, Inc.
14250 N.W. Science Park Drive
Portland, OR 97229
(503) 626-2291

Digital Vision
270 Bridge Street
Dedham, MA 02026
(617) 329-5400

MASS Microsystems
810 W. Maude Avenue
Sunnyvale, CA 94086
(408) 522-1200
Fax: (408) 733-5499
AppleLink: D0817

Orange Micro, Inc.
1400 N. Lakeview Avenue
Anaheim, CA 92807
(714) 779-2772
1-800-223-8029

RasterOps Corporation
2500 Walsh Avenue
Santa Clara, CA 95051
(408) 562-4200

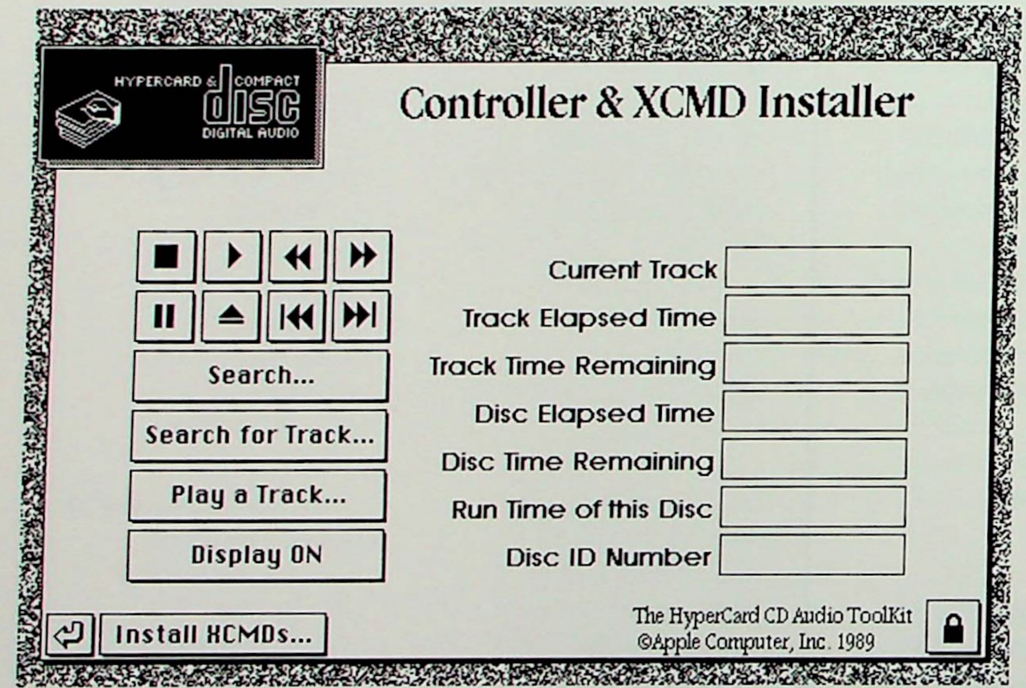
Truevision, Inc.
7340 Shadeland Station
Indianapolis, IN 46256
(317) 841-0332

VideoLogic
245 First Street
Cambridge, MA 02142
(617) 494-0530
Fax: (617) 494-0534

Workstation Technologies, Inc.
18004 Sky Park Circle
Irvine, CA 92714
(714) 250-8983
Fax: (714) 250-8969

HyperCard and Multimedia

From the beginning, a prime mission of Apple's HyperCard development team was to make it easy for any Macintosh user to control multimedia devices. The March/April 1990 issue of the Technical Bulletin discussed the HyperCard CD Audio Toolkit, available from APDA. This set of extensions gives HyperCard users access to, and control over, the audio tracks on compact discs (as well as the audio tracks on CD-ROMs), letting you add top-quality sound to presentations and lessons.



CD Audio Toolkit

But audio CD players aren't the only devices that you can control via a Macintosh. There are products that control videocassette recorders, laserdisc players, slide projectors, and sound and lighting systems. Some use MIDI (Musical Instrument Digital Interface, a protocol for exchanging digital information among peripheral devices and between those devices and computers) in addition to HyperCard.

Videotape

Sony Corporation manufactures 8mm VCRs, VHS VCRs, and still video cameras and players that use two video control standards, which Sony calls Control-L and Control-S. Devices that use these standards can be controlled via VidClip XCMDs (external commands) for HyperCard. VidClip XCMDs are available from APDA.

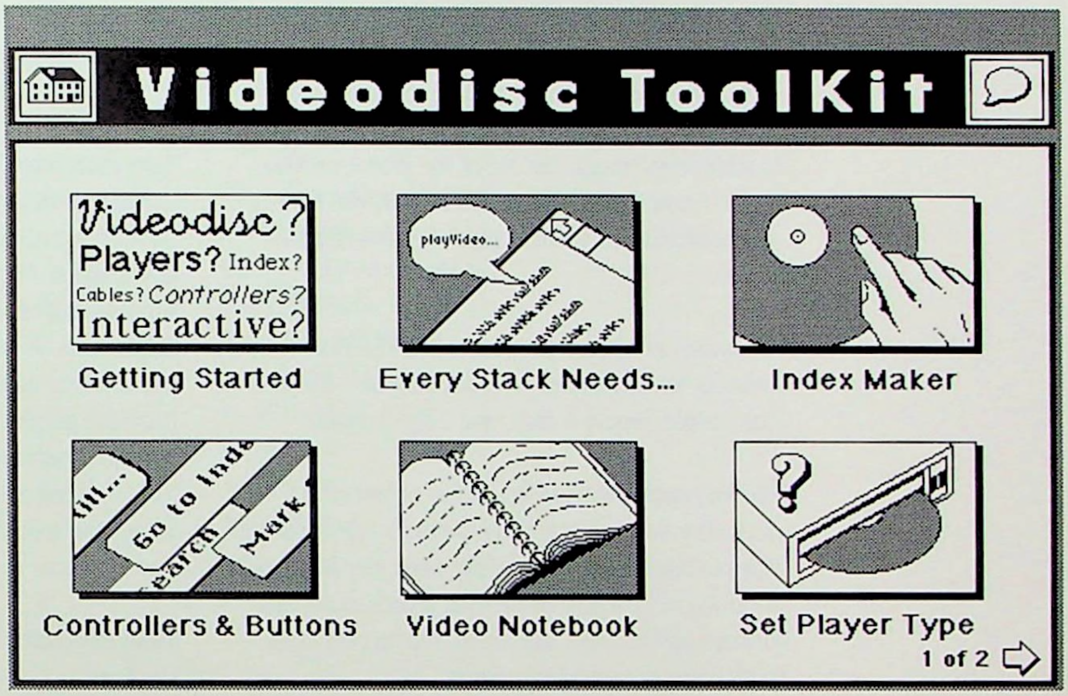
VidClip provides access to specific locations on tape, although this access is not as precise as with videodisc. It is possible to get within about 5 frames with the typical Control-L/S VCR. Because locating specific frames on low- to mid-priced VCRs is not possible, the usual expectation with VCRs is just to get close to (and in front of) the beginning of a video segment, start the playback, finish the segment, stop the playback, then cue to the next segment and continue.

Laserdisc

Other XCMDs let HyperCard control laserdisc players. The HyperCard Videodisc Toolkit, distributed by APDA, contains XCMDs that support laserdisc players from Pioneer, Sony, and Hitachi. For a list of supported laserdisc models, see "Laserdisc Q&A" on page 43.

The HyperCard Videodisc Toolkit includes:

- Videodisc Stack, an introduction to interactive video
- Videodisc Commands, a list of all HyperTalk videodisc commands
- Index Stack, a videodisc indexing tool
- ResCopy, a resource copier
- Notebook, a collection of addresses related to interactive videodisc
- Video Tips
- Advanced Material, which consists of documentation and source code for programmers who want to write their own videodisc drivers or communicate directly to the driver through the serial port of the Macintosh
- NASA Stack, a sample interactive video stack
- Presentation Maker, a tool that makes it easy to set up and play any number of videodisc segments



HyperCard Videodisc Toolkit

The Voyager Company also publishes XCMDs for many laserdisc models from Pioneer, Sony, Hitachi, Philips, and Magnavox—including some PAL (European broadcast standard) models. These XCMDs are available from both APDA and Voyager.

The Voyager VideoStack is a toolkit for developing interactive videodisc applications with HyperCard. It features more than 35 customizable control buttons, the ability to define events and make buttons that activate them, and automatic installation of video drivers into HyperCard stacks. VideoStack supports time mode with CLV discs. (CLV stands for constant linear velocity, as opposed to CAV, or constant angular velocity.) This allows a stack to tell the player, for example, to go to "19 minutes, 12 seconds" and begin playing until it reaches "21 minutes, 32 seconds." This is not precisely frame-accurate, but in many situations provides sufficiently accurate control. CAV is more desirable because you can do freeze frames, and you can address a specific frame, that is, "goto frame xxx." This *is* frame-accurate.

VideoStack 8000 Extension supports the special features of the Pioneer 8000 player, such as CLV still-frame and CLV frame search, digital sound control, and still-frame with audio. CLV still-frame is achieved through the use of the Pioneer 8000's digital frame buffer. The Pioneer 8000 can search to a particular frame and "grab" it into its digital buffer.

A Voyager hardware product called The Box controls "combination" laserdisc players—those that handle 5-inch, 8-inch, and 12-inch discs.

The Voyager Video DA is a series of Macintosh desk accessories that let you control some Sony and Pioneer laserdisc players while using any Macintosh application. These DAs provide search, scan, fast forward and reverse, still frame, repeat play, and (with some players) text overlay.

MIDI Sound and Lighting Systems

Sound systems and lighting systems can be controlled via MIDI. Many audio mixing boards, audio equalizers, audio delay and reverb devices, and lighting control boards have MIDI connections built in. APDA'S MIDI Management Tools includes the MIDI Manager, MIDI drivers, PatchBay, and Looking Glass. MIDI Manager is a toolkit that enables developers to create ports for MIDI data, and to transfer such data to and from MIDI devices. PatchBay is a graphic interface for connecting ports. Looking Glass is an inexpensive MIDI terminal.

J. L. Cooper Electronics has a number of products of interest: PPS 100 is a MIDI/SMPTE synchronizer that works with many Macintosh postproduction packages. MSB Plus is a MIDI switchbox and processing device. MAGI II is a professional console automation system.

Opcode Systems' customizable MIDI Play stack includes XCMDs for playing back MIDI files created in full-featured MIDI sequencers.

Two shareware XCMD sets for interfacing HyperCard to MIDI devices are available on many electronic bulletin boards and from commercial software distributors: HyperMIDI is a set of XCMDs for sending and receiving MIDI data from within HyperCard. It comes with several cards demonstrating different methods of managing MIDI data. It also provides graphic "sliders" that you can use to control any MIDI parameter. Another stack, called MIDI XCMD, is not as fully featured as HyperMIDI, but allows the recording and playback of a MIDI performance.

Slide Projectors and Other Switch-Controlled Devices

The remote-control cables on some slide projectors can be replaced with MIDI devices. Peavey Electronics' AMR division is one manufacturer of such devices.

Putting Them Together

There are many ways to integrate these various controllers into one application. A HyperCard stack that has access to XCMDs for VCRs, laserdiscs, and MIDI would be able to control several devices at the click of a HyperCard button. MacroMind Director 2.0 can use XCMDs from HyperCard, as well as its own XObjects, letting you control devices from within a Director "movie" much as you would from within a HyperCard stack.

Vendors Mentioned in This Article

APDA
Apple Computer, Inc.
20525 Mariani Avenue, M/S 33G
Cupertino, CA 95014
TLX: 171-576
1-800-282-2732 (U.S.)
1-800-637-0029 (Canada)
(408) 562-3910 (all other locations)
Fax: (408) 562-3971
AppleLink: APDA
CompuServe: 76666,2405
MCI: Postrom
GEnie: A.DEVELOPER3

- HyperCard CD Audio Toolkit
- HyperCard Videodisc Toolkit
- MIDI Management Tools
- VidClip XCMDs

The Voyager Company
1351 Pacific Coast Highway, 3rd Floor
Santa Monica, CA 90401
(213) 451-1383
In California: 1-800-443-2001
Outside California: 1-800-446-2001

- The Voyager VideoStack
- The Voyager Video DA
- VideoStack 8000 Extension
- The Box
- Serial cables for connecting Macintosh computers to laserdisc players

Opcode Systems, Inc.
3641 Haven, Suite A
Menlo Park, CA 94025-1010
(415) 369-8131

Peavey Electronics
711 A Street
Meridian, MS 39302-2898
(601) 483-5365

J. L. Cooper Electronics
13478 Beach Avenue
Marina del Rey, CA 90292
(213) 306-4131
Fax: (213) 822-2252
AppleLink: D1776

- MIDI Mute
- MixMate
- PPS 100
- MSB Plus

MediaMaker: Multimedia "For the Rest of Us"

By Andrew Harris
Apple Technical Information Services Department

Thanks to MacroMind, Inc. for providing details about its products.

Multimedia presentations are exciting and powerful ways to express your ideas. Yet, despite great strides in simplifying the user interface over the last few years, putting together such presentations has remained a fairly complicated, expensive, and daunting task for the average computer user.

Now MacroMind, Inc., in association with the MultiMedia Corporation of BBC fame, has created a simple "click and drag" user interface for interactive multimedia authoring. Called MediaMaker, it is an easy-to-use environment for editing, assembling, and synchronizing video with Macintosh graphics, sound, and animation ($495).

Unlike the MacroMind Director program, which is geared more toward professional-level authoring, MediaMaker allows casual users to quickly put together multimedia presentations. Now even nonspecialists can tap into existing corporate video libraries, shoot new video footage, or utilize a variety of available general-purpose "clip video" to deliver sales, marketing, technical, entertainment, or educational messages. With a flat-panel display for overhead projectors, you can do interactive presentations for groups, or you can publish your presentations on simple VHS videotape.

MediaMaker uses two types of media documents: Collections and Sequences. Collections are media databases that allow users to add, organize, and edit elements of videotape, videodisc, compact disc audio, Macintosh audio, graphics, and animations. Users play back the media simply by double-clicking any picon ("picture icon," a visual cue of the media's content).

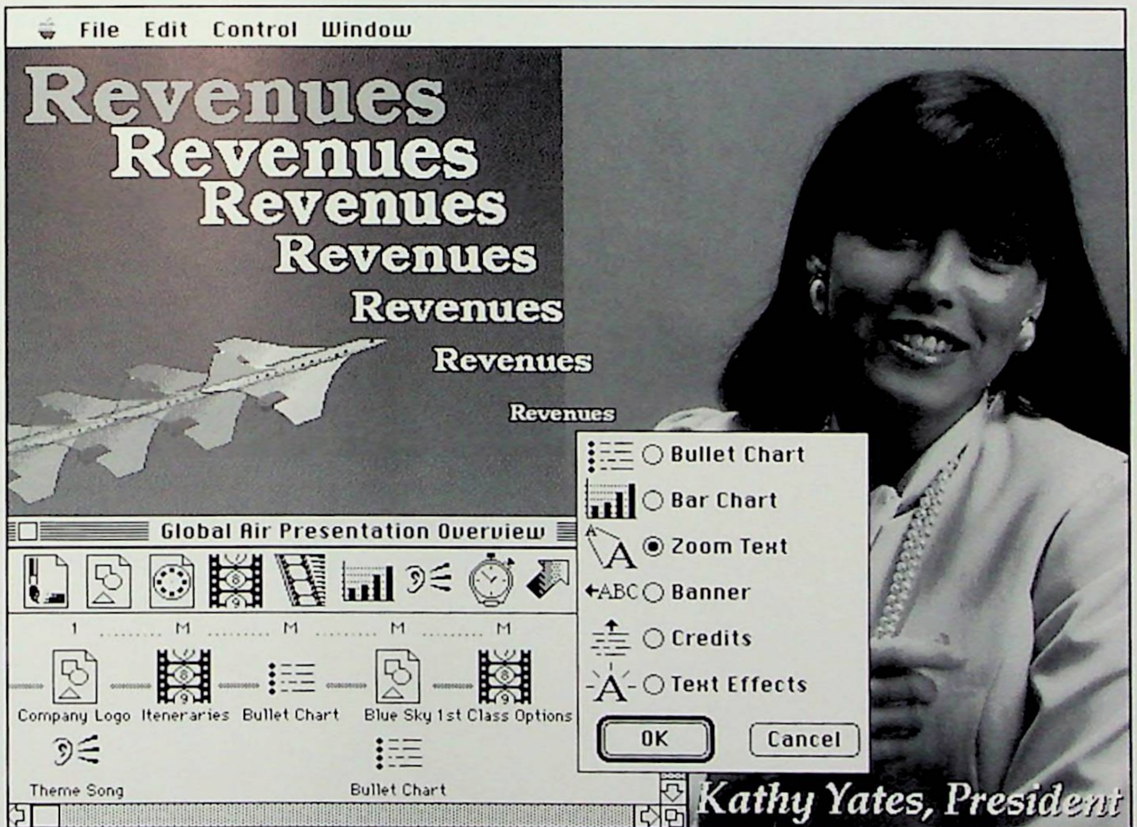
The idea is similar to the folders and files metaphor of the Macintosh Finder™ environment. We're all familiar with how a Macintosh folder can contain many files and folders. Once all these elements are within a folder, they can be copied and moved around easily, as though they were a single object. Similarly, a MediaMaker collection can contain any number of picons that, once they've been collected together, can be handled as a single multimedia object. You can have as many picons in a collection as you want, and you can copy picons from one collection to another.

Playback is as simple as double-clicking a picon. Users can drag the media elements from the Collection window into the Sequence window. Sequences provide a simple system for laying out and synchronizing the media elements over time. MediaMaker Sequences can be output to video using the MediaMaker Print to Tape feature, just as you print a document to a printer.

(Note: MediaMaker is a software package only; you'll have to provide special hardware and cabling to input and output audio and video. At the very least, you'll probably need a video digitizing card and a videotape output device. MediaMaker is compatible with all Macintosh models. It requires 2 megabytes of RAM, and 4 megabytes is recommended. Contact MacroMind for a current list of recommended third-party products.)

All MacroMind products work together, allowing you to turn your Macintosh into a sophisticated desktop video studio. In addition to MediaMaker, MacroMind currently offers:

- Director 2.0, a professional interactive multimedia presentation and animation tool that includes MacroMind Player, a run-time playback application that allows you to create animations and send them to individuals who don't have the Director 2.0 application ($695).
- MacroMind Three-D, a three-dimensional animation, rendering, and image manipulation tool for the Macintosh ($1,495).
- MacroMind Accelerator, a utility program that speeds up and smooths animations for professional-quality output ($195).
- Clip sound and animation sequences, available in CD-ROM format ($195) or floppy disk format ($59.95 per disk).



- MacroMind Windows Player, a run-time environment that allows users to play back MacroMind Director documents on a PC running Microsoft Windows 3.0.

MacroMind also has an XObject Developers Toolkit ($20) for programmers who want to write special computer code for enhancing MacroMind Director

and future MacroMind products. XObjects (external object programs) are functionally similar to HyperCard XCMDs (external commands), in that they give users control over external media devices, database interfacing, and numerical calculations. Additionally, XObjects in MacroMind Director let users add pop-up menus, windows, and XCMDs to their multimedia presentations and interactive training materials. Hardware and software vendors that are developing XObjects include RasterOps, Radius, Truevision, VENT, Videomedia, Diaquest, and ARTI.

Never has there been a better time to take the multimedia plunge. With authoring software easier to use than ever, products such as those from MacroMind herald the second phase of the personal computer revolution, which was started by desktop publishing. Desktop multimedia has come of age.

For further information, see the article "MacroMind Products: Movies in HyperCard" in the March–April 1990 issue of *Macintosh Technical Bulletin.* Contact MacroMind at:

MacroMind, Inc.
410 Townsend, Suite 408
San Francisco, CA 94107
(415) 442-0200

Computer Video Technology Overview

This article is adapted from training information developed by the Apple Sales Technical Support group in response to questions about video and graphics.

The term "graphics" usually refers to visual information in the form of images rather than in the form of text. However, current computers do not differentiate between the two when producing an image on the screen of a monitor or any other display device, and the term "computer graphics" encompasses almost all human interaction with computers today. This article discusses computer video graphics and technology terms, standards, and conventions.

Computer graphics require the following three components:

- The CPU, for computing and manipulation of images
- The graphics controller, a card (in a modular system) or graphics circuitry (in a compact system) for processing the display signal
- The monitor, for displaying the image by acting as a window into the graphics controller

The CRT Monitor

The most common method of displaying computer information is the cathode ray tube, or CRT. Though the technology used to create the image on a CRT can vary, the most popular is the raster scan monitor. The Macintosh computer and Apple monitors use raster technology.

A computer or television CRT is constructed within a flask-shaped glass bottle. The large, rounded end is coated with light-emitting phosphors, and is called the screen or tube face. The phosphors glow when struck by electrons. At the opposite end of the bottle, a cathode heats at levels controlled by the voltage of the computer video signal. The heating cathode emits the electrons that strike the phosphors. The electrons are pulled off the cathode by an electrostatic grid, which also acts as the brightness control for the monitor. The greater the amount of electrons drawn off the monitor, the brighter the phosphors glow when struck by them.

To help direct the electrons, two other magnetic or electrostatic forces are created. The first force the electrons encounter is a focus, which tightens the electrons into a beam. The second is a metal coil carrying a high voltage; it controls the position of the beam by deflecting it toward a target point on the screen. Finally, a high-voltage anode is used to charge the electrons passing down the tube from the cathode to the faceplate and blast them onto the phosphors (see Figure 1 on the next page).

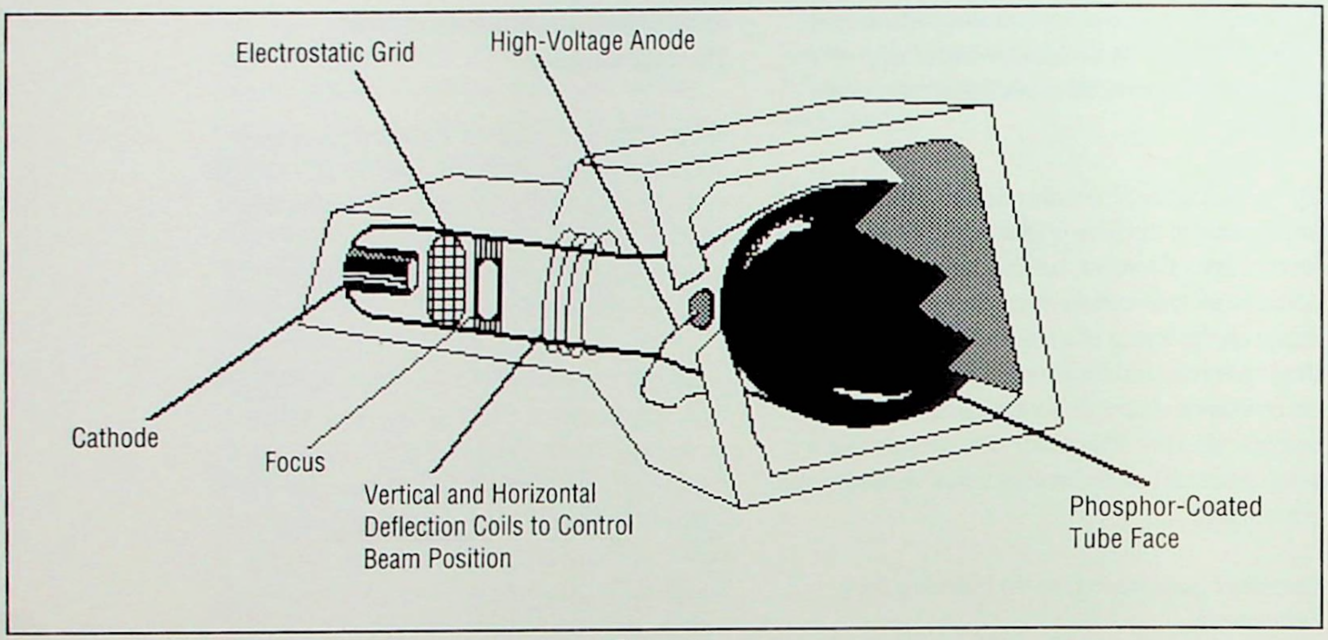


Figure 1
Monitor Picture Tube Components

To position the electron beam, vertical and horizontal deflection circuits are controlled by video signal pulses that direct each circuit to deflect the beam. The vertical sweep circuits constantly move the electron beam up and down. The horizontal sweep circuits move constantly in a left-to-right pattern. The raster scan method is a horizontal left-to-right scan of lines; the beam moves horizontally from left to right until it completes a scan line. It then moves left to the beginning of the line. (See Figure 2.)

By the time it returns to the beginning, the vertical sweep that has been constantly moving the beam downward has had time to move the beam down one phosphor row. After an entire screen of phosphors has been scanned, the monitor is directed by a vertical retrace signal to reposition the electron beam at the top of the screen, and again begin the horizontal scanning of the phosphors.

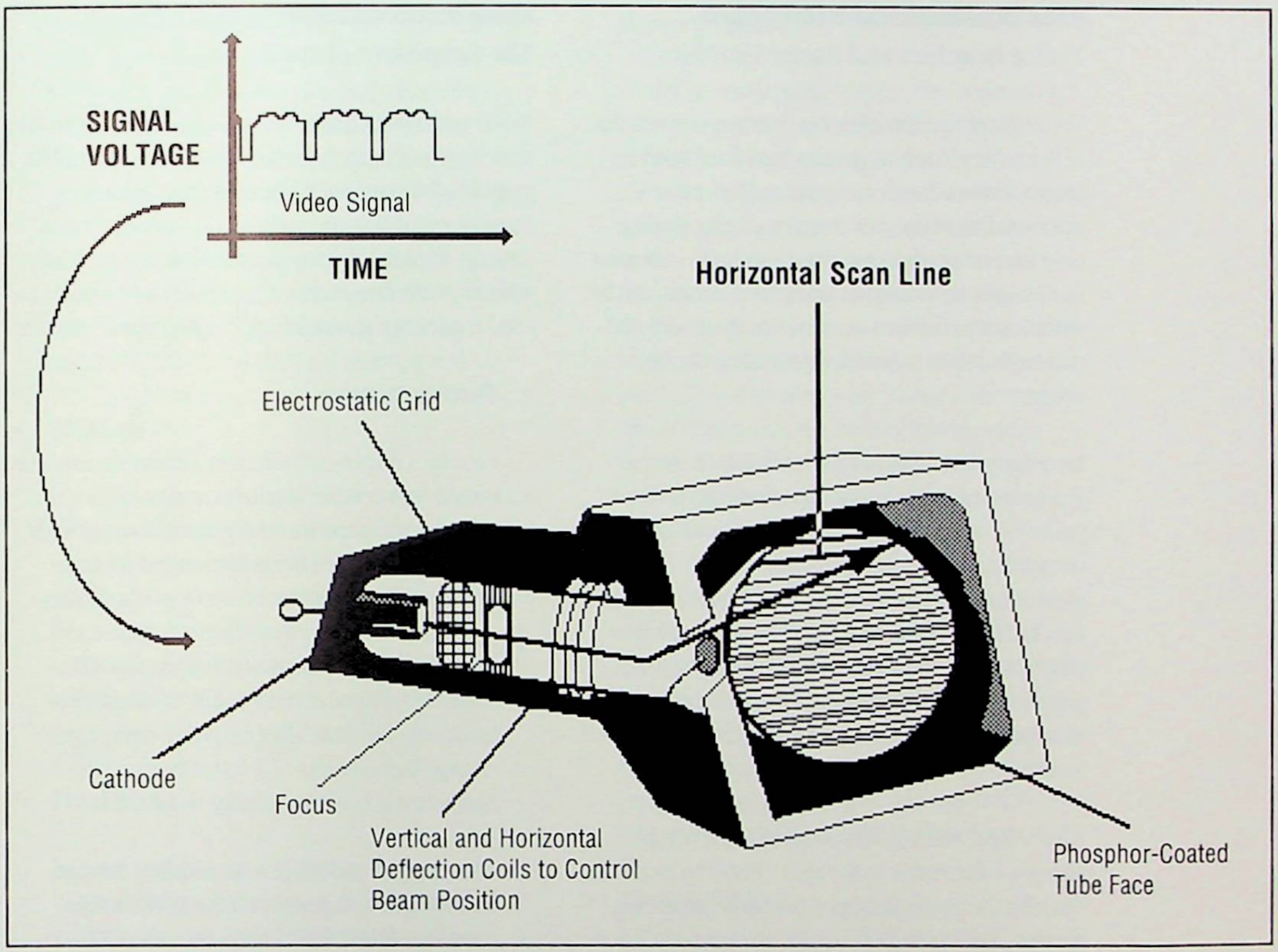


Figure 2
CRT Displaying Horizontal Scans

The phosphors on the CRT faceplate dim quickly and must be constantly refreshed to the desired luminance level. The decay rate of the phosphors is called persistence, and is important in calculating the required refresh period of each pixel. As an example, if the persistence of the phosphor is very short, the video picture might show only a single dot moving across the screen as the electron beam sweeps down the screen one horizontal line at a time. If the phosphor decay is a little faster than the scan period of the beam, a flicker may appear where the phosphors have decayed to black. If the persistence is higher than the electron beam scan rate, a ghosting image may appear.

Vector Graphics and Raster Graphics

Vector graphics (line-drawing) systems evolved out of the basic plotter design first used for displaying graphics created with computers. The vector graphics system reduces memory cost by storing only the end points needed to draw lines. Complex line images, including vector-defined curves, can be stored on a mainframe or mass-storage device and transmitted to a terminal for generating the final image.

Raster graphics followed the invention of vector graphics—an evolution that resulted from reduced prices for computer memory. Raster graphics computers use a rectangular array of picture elements, called pixels (or sometimes pels), mapped into RAM. This technique is called bit mapping or pixel mapping and is the method of graphics data organization used by the Macintosh family (and by most personal computers, including the Apple II family).

Note: "Pels" is used here to describe the actual phosphor dot visible to the eye. "Pixels" is used to describe the computer signal or data representing the dot. This distinction is made to avoid confusion in discussions of picture elements in bits, wave forms, and phosphors.

In raster graphics systems, an image is first created within the computer for display on a raster graphics CRT; a complete image is drawn as a series of horizontal lines. A screen can be updated only as quickly as the computer circuitry can draw all of the horizontal lines on the screen, as compared with the drawing circuitry of vector systems, which can update and draw individual lines that make up the images.

The Graphics Controller

Video generation begins with the graphics controller, which converts graphics data into a video signal for a graphics display device. Because the graphics controller and accompanying video processing circuitry limit the display devices that can be used with a system, the purpose for which a computer is used is greatly influenced by the graphics controller.

- **Display Memory**

  Graphics display information requires computer memory to contain a graphic image. The memory required is usually in the form of RAM. The allocated memory is also called a frame buffer or display memory.

  A frame buffer consists of a full display of logically mapped screen pixels in memory locations. Because the computer can quickly change the contents of a frame buffer, only a single frame buffer is usually required.

  The Apple II and Macintosh families contain frame buffers mapped into the addressable memory of the CPU. This means the CPU can access the display data for reads or writes.

- **Character Maps**

  Character maps are predefined pixel maps, usually containing—though not limited to—alphanumeric characters. Because they reference predefined individual pixel maps of characters, graphics displays that use character maps take up far less memory and processing time than those that draw the pixel image.

These individual character maps can be selected over and over, as is the case with text characters. The video signal can be processed from the single character map referenced from the computer screen character map. Character generators and maps are found in the Apple II family; the Macintosh family does not use them because the Font Manager uses a flexible, fast method of drawing characters and places them in a frame buffer. Character maps are the standard IBM PC mode for generating text.

- **Bit Maps**

Used in raster scan displays, bit maps store pixel image data as single-bit values. Bit mapping requires large amounts of memory to store pixel information; a one-bit-to-pixel relationship is needed for monochrome, single-color, and two-color image generation. Color pixels require groups of bits signifying the color or shade of each pixel. This is known as "pixel mapping."

- **Pixel Maps**

In pixel mapping, the video generation circuitry of the graphics system does not need to calculate the vectors of data, because the information is stored in a pixel map. The rate at which a new image is displayed depends on the speed of display memory updates by the computer, the CPU processing speed, and the speed of screen updates. Images previously stored in the graphics system's frame buffer continue to be updated at the speed of the vertical refresh rate. The basic idea is the same for all raster graphics computers.

- **Memory Planes**

To define overlapping graphic components or color pixel values, multiple bit maps can be defined for a display area. In the case of color plane separation, three planes can be defined to a single pixel, each with red, green, or blue values. The pixel locations of the bit values correspond from plane to plane. For example, the bits for location 1,1 on each plane are added to calculate the total color value of the display pixel. This is known as the planar color model, and contrasts with the chunky model, which defines a color pixel in successive bits, or the chunky-planar model, which defines pixels using a combination of the two.

Another use for memory planes is to map different images to the same graphics device. This enables two video sources to share a single monitor; the image source is selected or added from the frame buffer of choice. For example, you might put digitized video into one frame buffer, a graphic in another, and use a third for displaying a combination of the two sources.

- **Lookup Tables**

One of the ways to save memory and allow flexibility in color manipulation is to map the color pixel values to a table that stores the actual color values. This color reference stored in the pixel frame buffer directs the video controller to the actual larger color value, allowing greater variance in color values than is otherwise possible with the same amount of memory and resolution. Using a lookup table, a program can

change the colors in an entire display—or change a color image made up of thousands of color pixels—by changing one bit in the lookup table.

- **Digital-to-Analog Converters for Video**

  One of the final steps in computer graphics generation is to convert the computer image to a video signal. This is achieved by digital-to-analog converters (also called "D-to-A converters"). Today, only a single chip is required to convert most computer data to a video signal.

Video Signals

Video signals were first used as linear representations of an object scanned from a video camera that detects light reflections and emanations. Computers simulate an object by artificially creating the same signals. Regardless of whether the image is generated by a camera measuring light intensity entering its optical system, or manufactured from computer data, the generated signal must represent this condition of light reflection or emanation from an object.

A raster scan follows a consistent sweeping pattern. To regulate the pattern for consistent reproduction of the video or computer graphics image, horizontal and vertical synchronizing signals are placed within the video signal to regulate the timing of the scan.

When an electron beam finishes its sweep right, it must be signaled to return to the beginning of the next line. This is the horizontal sync or retrace signal.

Sync signals can be placed within the video signal or transmitted to the monitor separately. The sync signal consists of a falling edge in the signal. The time period for the cathode tube to swing back from the end of one line to the beginning of the next line downward is called the horizontal retrace time. During this time, the cathode tube is turned off to prevent a line from showing its path on a screen; this results in a low voltage level in the video signal describing black (cathode beam off).

When the cathode beam has scanned across and down the entire screen, a signal is sent to the monitor sweep circuits to begin moving the beam to the top of the screen. This is called the vertical sync signal.

The period in which the cathode beam is turned off and moving to the top of the screen is called the vertical retrace period. The entire time in which the cathode beam is moving downward (it does not stop during horizontal movement) is called the vertical sweep. Timing signals require great precision; the horizontal and vertical sync signals must be sent from the graphics controller and arrive at exactly the moment when the cathode beam finishes its sweep. Also, video signal blanking periods must be correctly positioned so that the cathode beam sweep is not visible during its retrace.

The sync signals can be placed within the video signal or transmitted separately. They may also be combined onto the same signal line to represent a composite sync signal, or combined with video information to create a composite video signal.

- **Analog RGB Video**

RGB video is a video signal that is separated into its color components: red, green, and blue. The color selection relates to the human brain, which interprets visible wave frequencies (visible spectrum) by splitting them into perceived color. White light consists of equal levels of radiance throughout the visible spectrum. By using colors broadly separated on the spectrum, a greater mixture of possible colors can be found; red, green, and blue work best.

The controls most often found on a monitor are luminance (often incorrectly called brightness), hue (color), and saturation (contrast).

—Luminance (or intensity) is the power of the light reaching the eye. It is a relative value because the intensity of a light can change with different environments. For example, a bright candle light appears much dimmer in day light than in a dark room. This value is usually measured in the international unit for light intensity, called a "nit," or in foot lamberts.

—Hue is the color that appears dominant to the eye. The hue of a mixture of color is blue when your eye perceives more blue than other wavelengths.

—Saturation is the contained complement level of a viewed color, or the color added in equal parts to make white or—depending on the intensity—black or gray. (A white light at low intensity is gray, and with no intensity is black.)

Color monitors require three beams instead of the single beam used in monochrome monitors. Each color pixel is made up of three phosphors: red, green, and blue. Each of the three beams fires on only one type of color pixel. To prevent their striking the wrong phosphors, the beams must be blocked, or masked, from phosphors belonging to another beam.

The blocking of the separate beams is done through a shadow mask or aperture grill—a metal mask made up of wires or a specific pattern of holes in a grid (see Figure 3 on the next page). The spacing between openings is known as the grill pitch. The size of the grill pitch can enhance the sharpness of the monitor's displayed image by allowing smaller pixels. The three electron beams are designated to strike phosphors of a single color only.

To create a bright pixel, the monitor control circuitry must receive a video signal of the required level. The signal is then transferred into a higher voltage level at the cathode, forcing the cathode to emit more electrons. The more voltage applied to the cathode, the greater the amount of electrons emitted.

In RGB systems, three connections are made from the video monitor to the graphics controller. A fourth—composite sync—is sometimes used. When a monochrome image is taken from the signal, the signal is used for the shades of gray. However, the luminance (shades of gray) can be affected by the hue of the video signal and must be software-corrected to allow for the greatest range.

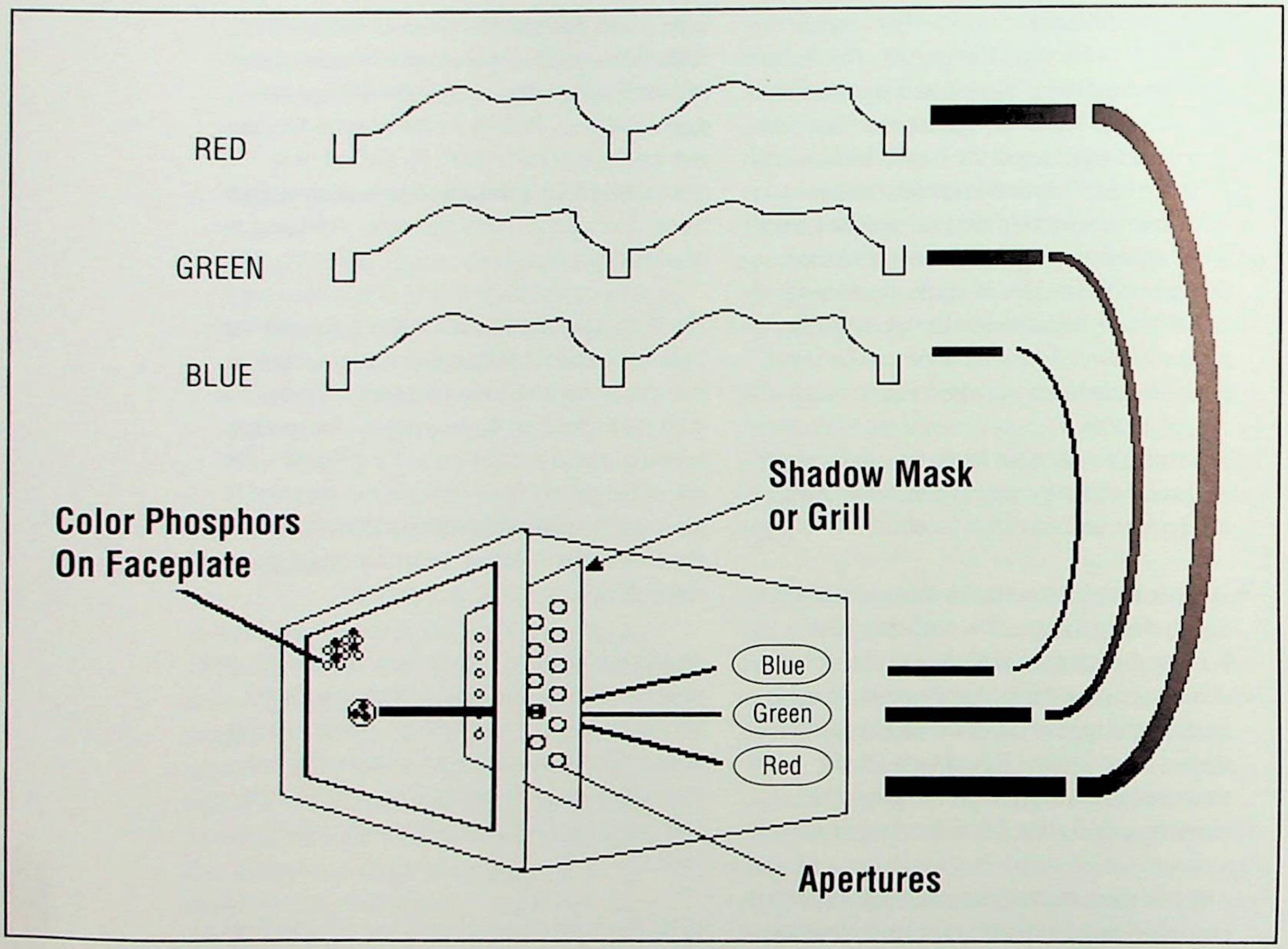


Figure 3
Analog RGB Signals and Monitor

The following conventions apply:

—In many analog RGB monitors, the green signal also contains the composite sync signal.

—Standard video, whether composite or analog, is usually a 1-volt signal, with black at 0 to .3 volt and white at 1 volt.

- **Digital Video**

Digital video signals are square wave signals (bits) that can be organized to represent values for the color of a screen pixel. In the case of black-and-white video (as in the Macintosh SE/30 and earlier models), only a single bit per pixel is needed. In some systems, groups of bits

define a particular color value—not the best color solution because it limits the number of colors that can be displayed; there are speed constraints for large color values. In digital video, monitor circuitry recalculates the values into the correct exposure and color mixture, just as a graphic controller does for analog video.

Video Signal Standards

To ensure compatibility between video display devices, video signal standards have been established by the Electronics Industries Association (EIA) and the National Television Standards Committee (NTSC). The standards were originally specified for black-and-white video, but have been modified and are used widely for color systems.

- **Interlace Scanning**

  Interlacing is a video display technique that fools the human eye into seeing a continuous, stable image. During the first video signal attempts, the limitations of 1950 technology created several conventions still in use today. Because of the limited bandwidths available to television signals, only minimal picture elements were transmitted to provide the visual image.

  Because an entire television screen of 525 lines cannot be transmitted in 1/60 second, only half of the lines—the even-numbered lines—are sent each 1/60 second. The successive display screen updates the odd-numbered lines. This happens fast enough that—to the human eye—the images combine to display the full 525 lines. The uneven number of lines per update ensures that the two images do not overlap each other; they alternate on the screen.

  The reason for the required 60 frames per second is that the line voltage in the United States is 60 Hz; interference from the line power can easily be avoided by matching that voltage. Europe's video standard (PAL) is 50 Hz, to match its 50-Hz line power.

  A drawback of interlaced video is that it is possible for adjacent horizontal lines of high contrast to flicker visibly. This is most apparent when using computer graphics, because they create unnaturally defined horizontal lines.

- **Progressive Scanning**

  An improvement over interlace scanning, progressive scanning resulted from the rapid growth in electronic and computer technology. Progressive scanning is most often used in computer-generated video; it is not a broadcast standard. This method, which involves scanning each line rather than every other line, is more costly than interlacing, but it removes the flickering that affects interlaced images. Macintosh video uses progressive scanning in its video generation.

- **RS-343**

  RS-343 is a high-resolution, monochrome, interlaced video standard. It can be used in a configuration of RS-343 video signals each containing a red, green, or blue component.

- **RS-170**

  RS-170 is a standard that defines the timing of broadcast video in the United States, Japan, and

several other countries. It specifies a 15.75-KHz horizontal and 60-Hz vertical interlaced scan frequency. Because of the limitations of video devices at the time the RS-170 standard was created in 1957, the speed of broadcast signals and picture tubes required the image to be displayed in part. An RS-170 video frame contains 525 lines and is displayed 60 times per second, for a total of 15,750 lines, or 15.75 KHz.

Of these lines, only the odd or even lines are updated with each frame. A total of 60 frames per second allows for a 30-frames-per-second, or 30-Hz, update of each line. Like the RS-343 standard, RS-170 is strictly a timing specification for monochrome video signals. By combining three such signals to control individual red, green, and blue sweep circuits, the full-color system is created (see "NTSC/RS-170A" below).

- **NTSC/RS-170A**

Modeled on the RS-170 standard, the RS-170A standard for color is the same as the standard commonly called "NTSC" because it was adopted by the National Television Standards Committee. It is now used in all government-regulated broadcast television systems in the United States, Japan, and a number of other countries.

When color televisions became available, it was necessary to place color onto the black-and-white RS-170 television broadcast bandwidths. With little working space, the solution was to use a color subcarrier signal, modulated onto the luminance signal. The luminance signal controls the intensity of the black-and-white image.

To place the color signal, or chrominance, onto the video signal, a color encoder combines the primary additive colors red, green, and blue into a wave form. An output device filters the color signal off the luminance signal and recalculates the original values.

PAL and SECAM

Because the power in most of Europe is 50 Hz 250 volts, a lower vertical frequency was chosen than the 60-Hz display rate of NTSC. This standard, the Phase Alternating Line (PAL) system, was developed in Germany and is used in several other countries. It describes a higher line resolution of 625 lines due to the decreased vertical refresh rate.

Another standard, developed in France, is SECAM (Systeme Electronique Couleur Avec Memoire), which also uses a 50-Hz vertical refresh and 625 lines. The three standards (NTSC, PAL, and SECAM) use different methods of color-encoding transmission signals, although the basic principles are the same.

Monitor Technology

As stated earlier in this article, the most commonly used video displays are CRTs. Other devices that receive video signals to display computer images include projectors and flat-panel displays. Video standards parameters for controlling such devices are largely based on the television technology available in the 1950s—conventions that are still in practice.

- **RGB Monitors**

RGB monitors use the red, green, and blue primary additive color model. Three different cathode ray tubes generate the electron beams that strike the faceplate holding the color pixels. A mask, or grill, filters each gun so that the beams strike only those color phosphors associated with each gun. A pel is made up of three color phosphors emitting light in unison to create the color dot on a screen.

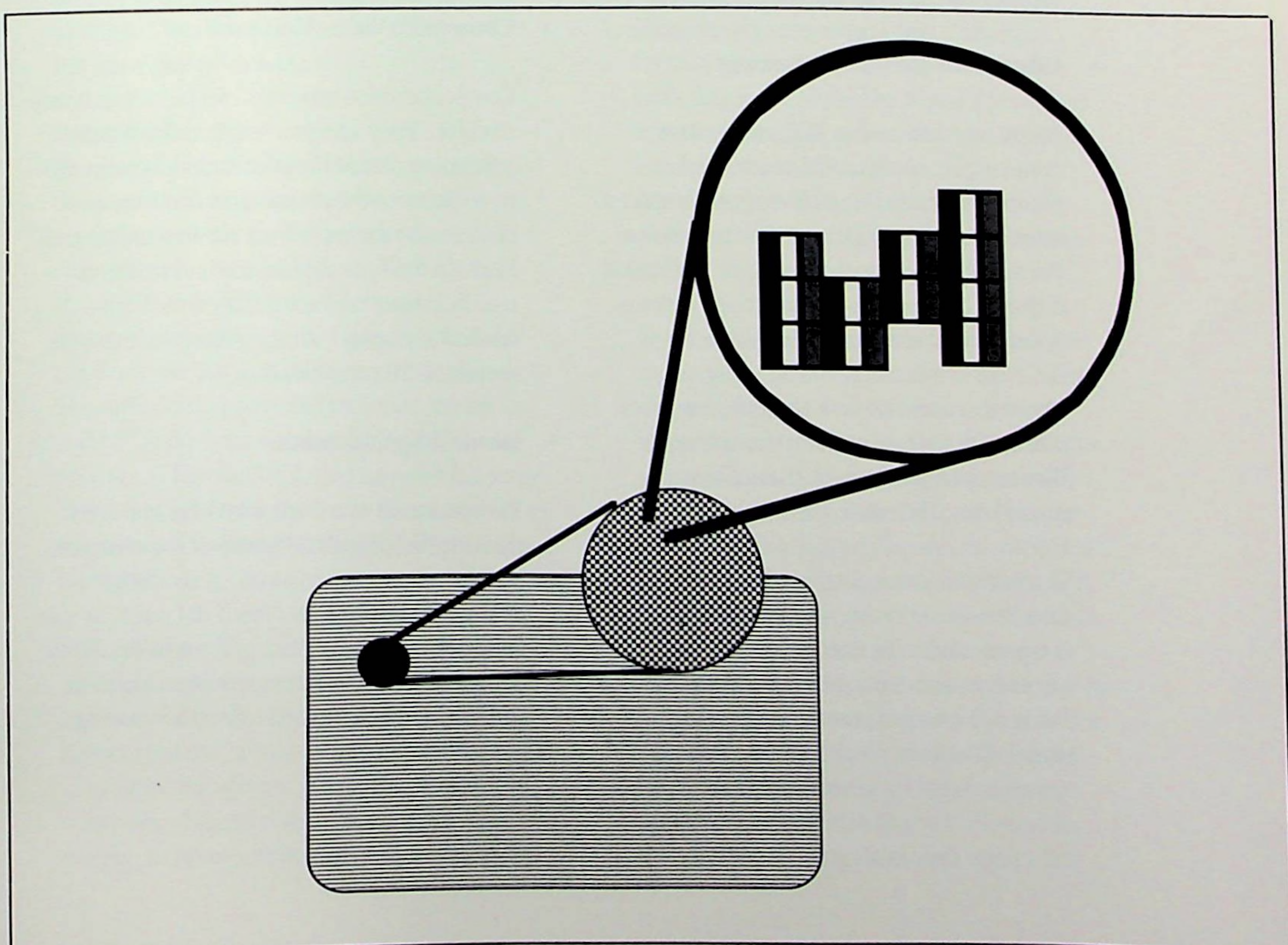


Figure 4
Trinitron Phosphors

- **Trinitron Technology**

  Trinitron technology, a proprietary technology from Sony Corporation, uses a vertical wire grill to separate three vertical bands of red, green, and blue phosphors (see Figure 4 on page 35). The wires are extremely thin and must be stabilized from vibration by one or two horizontal wires. The three cathode tubes are arranged in a single, round gun. The net effect is less distortion in fine patterns and lines. Sony Trinitron technology is used in the AppleColor High-Resolution RGB Monitor.

- **Other Color Monitor Technology**

  Another method used in RGB monitors is a delta, or triad, configuration of guns and phosphors, which, along with alternately spaced holes in a shadow mask, provides the means of directing the beams to the color pixel. The pixel displayed is triangular—causing moire patterns or distortion in some graphic displays.

  Yet another approach is to place all three tubes in line, with the guns adjacent to one another. They continue to scan through the alternately spaced holes, also causing moire patterns.

  Together with in-line guns, another type of shadow mask containing metal slots can be used to separate dots. The slots are still alternately spaced from line to line, although not as dramatically. Striped phosphors are used, instead of the usual phosphor dots. This method is probably closest to the Trinitron method of a wire grill with striped phosphors and a single three-beam gun.

- **Monochrome Monitors**

  Monochrome monitors display a single color (such as green, amber, or white) and black. They usually use only a single gun to strike color phosphors. To produce a black-and-white monitor, a layering of three color phosphors can be used to create the white pixel seen on the screen. This process differs from that used in a color monitor in that each of the colors' phosphor layers is struck simultaneously by the single gun to emit white light.

- **Composite Video Monitors**

  Composite video monitors can be monochrome or color. They accept a single video signal containing composite sync and video information. Because the circuit must combine and demodulate the color from the luminance and filter out the sync signals, the bandwidth is usually limited and not practical for high-resolution display. Most monitors of this type specify NTSC compatibility.

- **Monitor Specifications**

  The resolution of a display is defined by the frame buffer or logical display of the computer, and the required bandwidth. A monitor displaying the pixel data has a dot pitch, or size per pixel, and an aperture grill pitch, or spacing between pixels. Measurements for distortion and brightness of the CRT affect the viewing resolution.

Aperture grill pitch/dot pitch

The aperture grill pitch—the distance between the beginning of one color pixel and the next—defines much of the visible clarity of displayed images. The smaller this value, the higher the resolution. The measurement of the value is modified by the type of grill or shadow mask that is used. The triad configuration of phosphors requires a diagonal measurement, and a striped phosphor pixel requires a horizontal measurement. To adjust for the difference between the two measurements, the value of a triad or delta phosphor configuration must be multiplied by the square root of 3/2 to arrive at the same grill pitch scale.

Bandwidth

Bandwidth is a calculated value that describes the amount of data that must be processed per second to provide the full regeneration of the video signal's picture element. Without the required bandwidth for a video signal, a monitor's processing speed is unable to fully duplicate the pixel element, or pel, accurately. The tube doesn't have enough time to turn on and off, and a horizontal smearing or blurring appears. This effect is called rise-and-fall time, or the time taken for the beam to rise and fall to the required intensity level over the space of a phosphor.

FCC ratings

All Apple monitors are rated as FCC Class B monitors for home market and industrial and commercial use, a more stringent class than that of most PC equipment. Class B tests check for emissions of signal noise placed in connected wiring. In home environments, it is possible for an electronic device to emit signals (through connected cables and wires) that are receivable by radios or televisions. In essence, a monitor (or connecting cables) becomes a transmitter, interfering with communications. Radiated emissions tests show how much noise is emitted into free space between the range 30 MHz to 1 GHz.

Specifications for distortion

Display distortion usually occurs along the edges of the screen, because the angle of the beam is higher and the distance from gun to phosphor is greater at the edge. The angle causes the beam to strike through the shadow mask diagonally, hitting the adjacent phosphors as well as the target, and causing blurring of the edges. In older CRTs, you may notice very curved faceplates, an attempt to reduce distortion by decreasing the required deflection angle.

Flat-screen monitors are more inclined to show convergence problems, because of their shallow screen curves. As a rule of thumb, greater deflection angles require deflection circuits with greater accuracy. Distortion can be caused by a number of physical constraints on the monitor tube. The glass bottle influences the dispersion of the beam onto the faceplate. Problems such as bowing (which appears because of the bottle shape of monitors) can be corrected—as can many of the focus and conversion problems—by adjusting the electrostatic or magnetic grids that guide the electrons to the shadow mask hole and subsequently to the proper phosphor.

For Further Information

If you would like further information on the subject of computer video technology, the following books may be of interest.

Conrac Corporation, Conrac Division, *Raster Graphics Handbook,* Covina, CA, 1981.

Texas Instruments, *Understanding Communication Systems,* developed by the staff of the Texas Instruments Information Publishing Center, Indianapolis: H. W. Sams, 1984.

Media Integration from Apple

Rather than focusing efforts on providing a single hardware platform configuration or "multimedia machine," Apple intends to provide developers with a scalable set of hardware and software capabilities integrated across the modular Macintosh product line. Sound, video, CD-ROM, and HyperCard are the key technologies. While most of the following innovations will appear first in the modular family of Macintosh systems, many of the capabilities will eventually migrate to the compact line:

- Sound. Sound input and output will be incorporated in all future modular Macintosh systems. Apple will provide a text-to-speech replacement for the MacinTalk™ software that will produce higher-quality output with substantially improved accuracy and intelligibility. It will also support multiple voices and languages. In addition, Apple will establish human interface guidelines for sound input and management.

- Video. Apple will develop real-time software compression/decompression technology that runs on today's modular Macintosh systems—reducing by as much as 90 percent the storage required for digitized video. Apple also plans to integrate composite video output into future modular Macintosh computers and NuBus display cards. This will enable Macintosh video output to be sent directly to any video projection or VCR device.

- CD-ROM. Apple plans to lower cost and increase performance, creating products for a broader base of users. At the same time, Apple has efforts under way to make CD-ROM easy to integrate into Apple CPUs.

Apple continues to evolve HyperCard (see "HyperCard and Multimedia," page 18) as a development environment for multimedia applications, and a "staging area" for new multimedia capabilities. For example, Apple is planning HyperCard extensions for multimedia support, such as the control of videocassette players.

These activities are intended to encourage developers to join Apple in media integration. Joint efforts of Apple and third-party companies will evolve the Macintosh as a multimedia platform within a comprehensive, effective media interchange standard.

Using a Video Camera to Record Computer Screens: VideoSync Version 1.0

Recording the screen of a computer can be a problem when the computer scan rate is not equal to that of an NTSC camera. Most computer screens are updated at 60 Hz, a rate sometimes called NTSC timing.

When you shoot a computer screen with a faster scan rate, a rolling bar appears across the screen, caused by the vertical retrace of the computer (see "Computer Video Technology Overview," page 25). When the scan rate is very high, as in Macintosh displays, the screen appears to pulse because the bar is flashing so quickly.

VideoSync™ Version 1.0 is a Macintosh system software extension designed to improve the recording of Macintosh display screens using standard consumer video camera equipment. When the VideoSync file is added to the Macintosh System Folder, you can adjust the timing of an Apple display card from the Monitors Control Panel. The resulting Macintosh monitor image appears stable when viewed by an external NTSC video camera.

VideoSync requires any Macintosh II personal computer; Macintosh System Software Version 6.0.4 or later, or A/UX® Version 2.0 or later; an AppleColor High-Resolution RGB Monitor; and an Apple video card (Macintosh Display Card 4•8, 8•24, or 8•24GC; Apple High-Resolution Video Card; or Macintosh II Video Card). It also supports some third-party displays that work with Apple video cards.

Developers can license VideoSync directly from Apple as a stand-alone utility for video integration applications. The product is available from APDA.

For ordering information, contact APDA as follows:

APDA
Apple Computer, Inc.
20525 Mariani Avenue, M/S 33G
Cupertino, CA 95014
1-800-282-2732 (U.S.)
1-800-637-0029 (Canada)
(408) 562-3910 (other countries)
Fax: (408) 562-3971

AppleLink: APDA
CompuServe: 76666,2405
MCI: Postrom
GEnie: A.DEVELOPER3
MacNet: APDA

Multimedia Q&A

Q: Are there video cards that can record the Macintosh screen display in PAL video format?

A: Many video cards can send Macintosh images to videotape in the PAL format. Truevision NuVista cards, several RasterOps cards, and MASS Microsystems cards are capable of providing PAL output (see "Multimedia Solutions: Video Card Selection," page 8). Some of these cards require an external encoder box to provide the PAL connection. Please check with the manufacturer for exact configurations. The Macintosh Display Cards 8•24 and 8•24GC provide PAL output via Truevision's VIDI/O Box.

Q: Can you give me some video projection tips for creating multimedia presentations?

A: Following are several Macintosh video projection tips:

• A video projection system for the Macintosh II must support a horizontal frequency rate of at least 35 KHz. Try to provide some "headroom" by purchasing equipment with at least a 42-KHz horizontal frequency rate.

• Brightness is measured in lumens. Though 300 lumens is acceptable, 600 lumens is preferable in a room that seats 50 people or more.

• You need a special video cable or an adapter box to connect a projector to a computer in the Macintosh II family. Projection system vendors can provide the device, which separates the RGB and sync signals and connects through the video card for the AppleColor High-Resolution RGB Monitor.

• Standard projection screen sizes are 6 by 8 feet and 7 by 10 feet. Since most projection units have a default convergence set within ranges appropriate to these screen dimensions, it makes sense to use a standard size.

• If you choose a rear-screen projection option, you can improve the overall presentation by using screen drapes.

Q: I want to use the Macintosh to develop CD-I (compact disc interactive) applications. Is there a CD-I compatible player for the Macintosh? How can I develop an animation on the Macintosh, and then transfer it to CD-I? Can sounds be created and manipulated on the Macintosh, and then used on the CD-I device?

A: CD-I is not an industry standard. It is a total system (hardware/software/operating system) concept from Philips. CD-I is not just a disc, not just a disc drive, and not just a disc format. CD-I is a proposal for a self-contained system consisting of a computer, software, and an optical disc. A CD-I system is based on a 680x0 CPU with audio, video, and graphics coprocessors, a real-time operating system based on OS/9, lots of firmware, large RAM buffers, and an advanced CD player. In other words, it is an entirely separate (and competing) system from the Macintosh.

Macintosh computers can be used as a front-end device for assembling certain elements of CD-I. The video portion of CD-I is compressed from analog video sources; preparing Macintosh animations for this format is the same as preparing animations for videotape. Using a program such as MacroMind Director and an NTSC output video NuBus card, you can record the output onto videotape. Note that the quality of compressed video coming from CD-I compression methods is low compared with that of VHS tape. Generally, the playback of the video is around 12 frames per second for one-quarter screen. The CD-I proposal provides for only 30,000 colors in the video image—far short of the Macintosh 24-bit capability of 16.7 million colors.

Because CD-I uses digital audio, digital audio products from companies such as Digidesign and New England Digital can be used for mastering the audio portion of the CD-I system. However, the master audio must then be sent through the CD-I compression method, decreasing its quality.

Q: What are the latest compression tools available on the Macintosh? What is MACE? How does compression affect sound playback?

A: The established image compression methods for the Macintosh computer are designed for 24-bit still-image files. The Joint Photographic Experts Group (JPEG) has established the JPEG standard as one of the primary compression standards for still images in the digital domain. Storm Technology offers ImagePress Compression Software, which implements the JPEG standard on the Macintosh. Kodak offers Colorsqueeze, which uses the Kodak Image Compression (KIC) format, which is also JPEG-compatible. Digidesign implements its own compression technique in Digidesign Deck software, for use with the Digidesign Audiomedia digital audio NuBus card.

SuperMac recently announced technology under development that compresses 24-bit color images and video—as well as digital stereo audio—onto storage devices. The compression ratio is 25-to-1, with higher rates possible. The product will decompress video in real time at 30 frames per second for playback on the Macintosh. The card and software are scheduled for release in 1991.

Apple's Advanced Technology Group has also announced a video compression/decompression software project. A possible extension to 32-bit QuickDraw, the technology may be incorporated into system software as early as the end of 1991.

Macintosh Audio Compression and Expansion (MACE) is Apple's compression standard for digital audio on the Macintosh.

Audio compression can affect playback negatively by degrading the sound. The amount of degradation depends on the compression ratio that is used. Ratios of 6-to-1 and 3-to-1 are available. The 6-to-1 ratio is more likely to cause audible degradation, although, if you compress only voice narration, the 6-to-1 ratio may be acceptable. If you compress more complex sound, the 3-to-1 ratio produces better results than the 6-to-1 ratio.

Laserdisc Q&A

Q: I know of two methods of laserdisc recording: CAV and CLV. What's the difference between them?

A: Constant angular velocity (CAV) is capable of providing both freeze-frame and full-motion video. Without the use of digital frame buffers, constant linear velocity (CLV) can provide only the full-motion video. If you want both freeze frame and full motion, use CAV to create the laserdisc.

CAV's disadvantage is that it allows only 30 minutes of video to be placed on each side of the laserdisc. CAV plays only one frame in each revolution of the laserdisc, allowing the freeze-frame mode. CLV places more video on the disc; it allows 60 minutes per side. However, the number of frames per revolution is not constant, making the freeze-frame feature impossible.

Q: I would like to print my laserdisc. I have all the materials on videotape. Can it be done?

A: Laserdisc production houses have varying specifications. Generally, these companies want the master videotape in the 1-inch broadcast tape format; some may accept 3/4-inch broadcast tape. There are also precise specifications for the layout of information on these master videotapes. Different production companies may require slightly different layouts.

If material has been transferred from motion-picture film to videotape, there are special considerations for freeze-frame images. When transferring 24 frames a second (the film standard) to 30 frames a second (the NTSC video standard), the method used to compensate for the differing frame rates must be precisely controlled.

If the original material was shot on videotape, frame rate is not an issue. However, freeze-frame images do need special attention to prevent image flicker in the laserdisc freeze-frame display mode. Two methods are available: frame-accurate edits and multiple-frame recording.

- Frame-accurate edits allow you to record only one frame of video on the laserdisc for the freeze-frame image. This is the preferred technique.

- Multiple-frame records three frames on the laserdisc, using the middle frame as the freeze frame. This method quickly exhausts space on the disc; it uses three times the space needed for frame-accurate edits. Using a disc recorded with the multiple-frame method, you cannot view the freeze frames, frame by frame, without seeing the same image three times.

Many laserdisc production companies provide books, at no cost, that detail the many specific issues that must be addressed to produce a high-quality videodisc.

The following companies provide laserdisc mastering and pressing, as well as production information:

Disctronics
1120 Cosby Way
Anaheim, CA 92806
(714) 630-6700

Pioneer Communications
1058 East 230th Street
Carson, CA 90745
(213) 513-1016

3M Optical Recording Department
6023 South Garfield Avenue
Los Angeles, CA 90040
(213) 726-6350

Q: How long does it take to press a laserdisc?

A: The usual turnaround is 10 days—from the time a production company receives the master videotape until the duplicated discs are ready. If faster turnaround is required, same-day service is often available. Any turnaround of less than 10 days typically costs extra.

Happy Holidays! November Issue Includes 1990 HyperCard Stack

With the September–October issue, subscribers to the *Macintosh Technical Bulletin* received a HyperCard stack containing all articles from 1988 and 1989. Articles from 1990 were to be included with the January–February 1991 issue. However, the 1990 stack is ready early, and has been included with this month's issue. We hope the stacks of past issues prove to be a valuable support resource for you and your organization.

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